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BULLETIN No. 29—NEW SERIES.

U. S. DEPARTMENT OF AGRICULTURE,
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U. S. Department of Agriculture,
Washington, D. C.

THE FALL ARMY WORM AND VARIEGATED CUTWORM.

PREPARED UNDER THE DIRECTION OF THE ENTOMOLOGIST,

BY

F. H. CHITTENDEN,
ASSISTANT ENTOMOLOGIST.

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LETTER OF TRANSMITTAL.

U. S. Department of Agriculture,
Division of Entomology,
Washington, D. C., July 18, 1901.

Sir: I have the honor to transmit herewith the manuscript of a paper entitled "The fall army worm and variegated cutworm," prepared with his customary thoroughness by Mr. F. H. Chittenden, of this Division. The insects are both important crop pests and of wide distribution, the former ranging from the West Indies to the Great Lakes, the latter cosmopolitan, but while known to entomologists, general farmers, and truck growers for many years, their life histories have never before been made out. This complete account of these species will be of great interest to the economic entomologists of the country, and it contains ideas and suggestions of much practical value. I recommend the publication of this paper as Bulletin 29, new series, of this Division.

Respectfully,

L. O. Howard,
Entomologist.

Hon. James Wilson,
Secretary of Agriculture.

PREFACE.

The season of 1899 was marked by extensive outbreaks of the fall army worm (*Laphygma frugiperda* S. & A). During that season it was as injurious perhaps as any other insect, as it was destructive to a much longer list of crop plants and over a vast area of territory; in short, this attack was unprecedented in the insect's history. The species is common in most seasons and familiar to practical workers in entomology and to observing persons interested in agriculture, but, although it has been known as injurious for many years, its full history has never been investigated in all its details in any single locality, nor have any very complete accounts been published concerning it.

It was hoped during the season of 1900 to ascertain certain points as to the insect's life habits and economy that might have a bearing upon the practical treatment of the species as it occurs in the field and garden. For this reason many facts in relation to its biology learned during the season of 1899 were withheld from publication to await further observations. The season of 1900 was a disappointment as regards opportunity for the study of this insect, it seemingly having disappeared, at least as a pest, throughout the country. This experience is confirmatory of an opinion, held by the writer for some time in regard to this and several other species of similar distribution and of probable southern origin, that certain atmospheric and other conditions destroy them in such great numbers in their more northern range during the late fall and in the winter that few of the insects are left to propagate the species the following season, and that, when these more northern localities become restocked with large numbers of the insects, such reproduction has been due mainly to the flight of moths from southern localities where these conditions have not prevailed, and where they multiply in more nearly normal numbers in swamp land and similar locations.

It is to be regretted that the missing data can not be supplied, as it seems unwise to delay the publication of the ascertained facts awaiting more favorable conditions for observations which may not again offer for a year or two, or perhaps longer. The present account is as complete as can well be furnished at this time, and it is presented herewith in connection with a report of a similar outbreak of a cutworm which occurred during the season of 1900. That season was

remarkable for cutworm outbreaks in various portions of the country. Most prominent of the species concerned in injury was the variegated cutworm (*Peridroma saucia* Huebn.), this species in fact replacing the fall army worm as the injurious army worm of that year. Injury was to a still longer list of crop and other useful plants, but was somewhat more restricted than in the case of the fall army worm, although more or less damage was inflicted over a considerable portion of the United States and Canada, indicating that infestation was more general than reported. The principal losses were sustained on the Pacific slope from northern California to British Columbia.

The life history of the variegated cutworm is somewhat better known than that of the fall army worm, but something remains to be learned of both species.

The fall army worm and variegated cutworm differ considerably in habits, as also in distribution, for, whereas, the former feeds normally upon grasses, grains, and other Gramineæ, and less seldom injures garden vegetables and other plants except when driven to attack them by hunger, the latter is a regular inhabitant of the garden. Both are of growing importance as pests, and, as such outbreaks are apt to recur in the near future, it is desirable to place on record all known facts in regard to them.

F. H. C.

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THE FALL ARMY WORM AND THE VARIEGATED CUTWORM.

INTRODUCTION.

The history of economic entomology shows that nearly every year there are outbreaks of one or more species of caterpillars, which, from their habit of migrating in great numbers, have come to be familiarly termed "army worms." The normal habit of these caterpillars is the same as that of others of their kind, which includes cutworms. In ordinary seasons they feed chiefly on the grasses or weeds on which the parent moth has laid her eggs, or they may be present and feeding in our gardens, fields, and pasture land in small numbers, doing so little damage that their presence is not noticed. No class of insects however, are more subject to fluctuation in numbers in different seasons. When, therefore, for any reason their numbers become unduly increased, they first devour every form of vegetation that is palatable to them growing in their immediate neighborhood, and when this food has become exhausted they march in armies in search of other means of sustenance.

In recent years several army-worm outbreaks have been observed and recorded. The year 1896 was marked by an unprecedented outbreak of the true army worm; the year 1899 by a similar incursion of the fall army worm, and in 1900 the variegated cutworm became the most destructive of these species.

In 1899 the fall army worm ravaged a considerable portion of the United States east of the Rocky Mountain region. This species feeds by preference on grasses and related plants, and so frequently assumes the migratory habit that it has come to be classified as one of our principal army worms, second only to the army worm proper (*Leucania unipuncta* Haw). The unusual and widespread abundance of the fall army worm during the season mentioned, and in many States where it had not previously been known as the cause of serious trouble, was the more remarkable since not a single specimen of this insect was received the previous year from any of our many correspondents, although a few individuals were noticed by the writer and others in the vicinity of the District of Columbia, and because so few outbreaks have been reported since that year, one of these also in the District of Columbia.

Although the species is to be found ordinarily everywhere in the

eastern half of the United States, and it is tolerably well known, particularly in the South, as distinct from the true army worm, even to those not well versed in entomology its life history has not been thoroughly investigated in any single locality to the writer's knowledge. A search through available literature fails to show that the larva has been described in its various stages.

A third species of caterpillar, the spotted cutworm (*Noctua c-nigrum* Linn.), was also at work during the season of 1900, doing, however, less injury than the other species mentioned. Reports show that this insect was unusually destructive in Indiana and Connecticut and along the northern shore of Lake Ontario, where it seemed to take the place of the variegated cutworm which was so injurious in the western part of Canada. The species was also rather more abundant than usual in Maryland and Virginia. As with the two preceding species, it was destructive to all sorts of garden and root crops, and in one instance, observed in Connecticut, assumed the army-worm habit.

A preliminary notice of the injurious occurrences of the fall army worm was given in Bulletin No. 23 (n. s.), and similar articles on the variegated and spotted cutworms were published in Bulletin No. 27.

The two species which form the basis of the present publication have not the same origin, and are therefore of quite different distribution. It follows as a matter of course that a corresponding dissimilarity exists in their life economy.

The fall army worm is undoubtedly of Southern origin, and proof will be furnished to show that in its constant endeavors to obtain a permanent footing farther north than its natural range it is thwarted every few years by meteorologic conditions, the extreme cold of our more Northern States causing its death in great numbers in its hibernating quarters. On this hypothesis it would seem that the reappearance of the species in years after its destruction is to be accounted for by migrations of the moths from the South northward. The variegated cutworm, there is little doubt, is a foreign introduction, and was probably brought from the Old World at an early date, as the species has been known to naturalists for a considerable period.

Outbreaks of these and other species which travel in armies are frequently the cause of extreme alarm among farmers, fruit growers, and others whose crops are infested, and there is usually considerable apprehension of the reappearance of these insects in future seasons. As a consequence, it happens in army-worm seasons that the Division of Entomology of this Department and the entomologists of the various experiment stations are besieged as to the probabilities of further attack and the means to be employed in the destruction of the insects, so that a repetition of injury the next season can be averted.

It should be stated for the benefit of the general reader that the term army worm has been applied to several insects which have the habit

of congregating and migrating in great numbers. The common army worm and the wheat-head army worm are common forms. A few other species which occur in North America should be added. Among these are the erratic army worm (*Noctua fennica* Tausch.), which is known as the black cutworm in ordinary seasons; the cotton army worm, known commonly as the cotton worm (*Aletia argillacea* Hbn.), and the forest tent caterpillar so-called (*Clisiocampa disstria* Hbn.). All of the species mentioned belong to the Noctuidæ, with the exception of the last, which is a Bombycid. A name that has recently been proposed for this last is the forest army worm.

All of these species differ considerably in habit, and in order to prescribe the proper remedies it is necessary to have a thorough understanding of the insects' habits; in fact, frequent inquiry is made by those interested in the subject as to the full life histories of these species.

While it is matter of entomological history that a repetition of general outbreaks by army worms, or species referred to as such, seldom follow in successive years, still it is wisdom to guard against such a contingency, and, at the first intimation of the presence of the insects in numbers, to institute radical measures for their suppression. To those skilled in entomology there is little difficulty in recognizing the moths as well as the larvæ of these species, and this it is confidently believed will be facilitated by the illustrations and descriptions which are here given; but it is advised that those who feel unable to determine these insects beyond peradventure promptly send the material found to some one competent to make correct identifications, so that appropriate measures of control may be adopted without delay.

In the case of the irruptions of the fall army worm in 1899, and its scarcity the following year, there are reasons, which have been briefly mentioned and which will presently be set forth in greater detail, that we can assign for depletion in numbers following injurious attack. But the life economy of the variegated cutworm is so different that no reason for the lessening of the numbers of this insect during the present year (1901) can be conjectured other than that parasites, and perhaps some other natural enemies which were observed at work late in the season of 1900, would have, at least locally, a beneficial effect. It is possible, however, that diseases, either fungous or bacterial, might have been present in many of the regions over which the insect ranged in destructive numbers last year without their coming under the notice of anyone capable of determining them, and it is perhaps possible also that the condition of the weather in the Pacific States, in Kansas, and in some other States where this cutworm was especially destructive might have operated against overmultiplication.

These are points that remain to be studied in the life history of both the fall army worm and the variegated cutworm.

The occurrence of the fall army worm in numbers so far north as the District of Columbia in 1900 is somewhat indicative of a repetition of attack, for, although the species has apparently been practically killed out in the locality of this irruption, farther south conditions more favorable to the insect's development have been met with, and it may be that outbreaks will again occur in the near future. The early occurrence of this species in Texas in April, 1901, is still more suggestive, and it may be that this is the precursor of outbreaks through the Southern States.

Of the variegated cutworm it has already been stated that there are no reasons, except the historic fact that repetitions of severe outbreaks seldom happen in successive years, why this insect should not be troublesome in 1901 as it was in the previous year, although it is improbable that the attacks, if any occur, will be so serious as those of 1900. Whether or not either of these species becomes injurious during the next year or two, it is well, to employ a hackneyed expression that has been much used lately, "in time of peace prepare for war." It is desirable, therefore, to have a proper understanding of these species, that remedies may be applied in time and that the future may not witness the very serious losses that were encountered through the ravages of these two insects, the one in the East, in 1899, and the other in the far West, in 1900.

THE FALL ARMY WORM.

(*Laphygma frugiperda* S. & A.)

The fall army worm, or grass worm as it is also called in the South, like the common army worm, feeds normally on grasses and grains and certain forms of weeds, particularly such as belong to the Gramineæ or grass family, but will attack in its seasons of abundance almost any form of vegetation that is encountered in its line of march. At such times it becomes a pest in garden and orchard, on lawns and in greenhouses, as well as in pastures and in fields of grain. In most years it seems to be particularly destructive to winter wheat and other cereals, grasses, and other graminaceous plants, but it often does damage earlier in the season to various other crops. It especially attacks young corn in a very similar manner to the corn-ear worm, the young larvæ devouring the tender folded leaves and, as they increase in size, sometimes burrowing into the heart and destroying the forming ears.

The moths are nocturnal, and their eggs are deposited in clusters on grasses or other food plants, and (when these insects occur in abundance) often also on the leaves and twigs of trees, on the outer walls of buildings, and in similar locations.

The larvæ are frequently so dark in color as to readily escape recognition except when they are moving in numbers, particularly as it is their normal habit to conceal themselves during the daytime deep under grasses and to feed mostly at night, or at least not in the heat of the day.

A feature of this insect's attack, and one from which it derives its popular name of fall army worm, has always been emphasized, viz, that it seldom travels in numbers or does appreciable injury except in the fall. It is seldom noticed, therefore, except in the extreme South, earlier than the first of August, while the outbreaks of the common army worm usually occur prior to that time and seldom later.

There is practically no doubt that there are two or three generations of this species produced each year in its normal range, and, in seasons which favor its development, each succeeding generation usually becomes more destructive than that which preceded it; hence its great abundance late in the season, when it causes most destruction.

The infested territory during the season of 1899 comprised a very considerable portion of the United States east of the Rocky Mountains,

injury extending from portions of New York and New Jersey southward through Florida to Cuba and westward to Texas, and extending from there to Kansas, Nebraska, Ohio, Indiana, and Illinois. Infestation was rather general, perhaps more so than reported, along the Atlantic coast. It was also quite severe in some regions in the West.

DESCRIPTION OF THE MOTH.

The moth which produces the fall army worm is a member of the Noctuidæ, the same family as that of the true army worm, *Leucania unipuncta*, which includes the parents of the cutworms. These two moths, however, are quite unlike each other. *Laphygma frugiperda* being more nearly related to the genus Prodenia than to Leucania.

The moth is quite variable, there usually being in most lots two distinct forms. What appears to be the commonest form, at least the present year about the District of Columbia, is shown in the accompanying illustration (fig. 1 *a*). The fore-wings are rather dull grayish-brown above, and show in this color variety a pattern more or less similar to the one figured. The hind-wings are glistening white, with rosy reflections; the posterior portion of the border is more or less infuscated near the fringe, which has an inner dark line at this point; and the veins of this portion of the hind-wings are dark and distinct. In the more ornamental form of the moth the fore-wings have the appearance shown at *b*. In this form the insect looks very much like an owlet moth of the genus Prodenia, bearing particular resemblance to *P. ornithogalli*. The fore-wings are mottled or variegated with black and white, reddish-brown, and sometimes with pale bluish, yellowish, and other tints. The expanse of the fore-wings is from an inch to an inch and three-eighths. The great variability in the colors of adults appears to be unexplained, as extreme varieties of both forms figured may be found issuing from the same lot of larvæ and, indeed, probably from the same batch of eggs.[1]

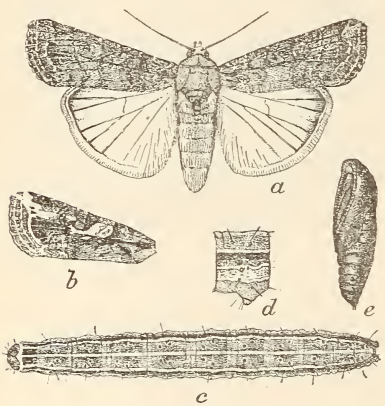

FIG. 1.—*Laphygma frugiperda: a*, moth, plain gray form; *b*, fore-wing of Prodenia-like form; *c*, larva extended; *d*, abdominal segment of larva, lateral view; *e*, pupa, lateral view—*d*, twice natural size; others enlarged one-fourth (author's illustration).

BRIEF DESCRIPTIONS OF THE EARLIER STAGES.

Since detailed technical descriptions of the egg and the different stages of the larvæ are presented, shorter popular descriptions, with

[1] It was noticed in a fairly large series of this moth reared by the writer during 1899 that the dull gray-colored individuals were mostly females, while the orna-

the accompanying illustrations, will suffice for practical purposes for the identification of these stages.

The egg.—At *a* of figure 2 the egg is shown above from the side, very much enlarged, and from above in the lower figure. The diameter is about half a millimeter, or about one thirty-second of an inch; but as the eggs are deposited in clusters of from 50, 60, and more, they may readily be detected in the exposed places on blades of grass and on leaves selected by the parent for their deposition. The surface is ribbed, as illustrated, and the color is dull white, with a pearly luster. The whole egg mass is covered with mouse-colored down from the body of the parent.

The newly hatched larva.—The larva when first hatched is quite unlike the full-grown caterpillar, the head being much larger in proportion and the body more hairy, presenting the appearance shown at *c* of figure 2. Its general aspect at this stage is nearly black, but after feeding the young larva becomes greenish, taking this color from the food which it has eaten. In this illustration the larva is necessarily shown lighter than in nature, in order that the hairs and markings may be seen.

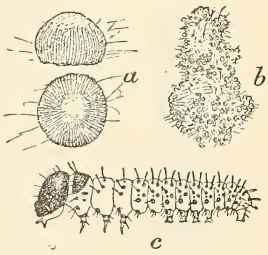

Fig. 2.—*Laphygma frugiperda: a*, egg from side in upper figure; *b*, from above in lower figure; *c*, newly hatched larva; *a*, *c*, much magnified; *b*, somewhat enlarged (original).

The mature larva.—The same variability observed in the coloring of the mature insect is seen in the caterpillars. When full grown they measure about an inch and a half in length. The larvæ resemble the common army worm in many particulars, and especially is this true of the lighter forms.

The body is striped on a ground color which varies above from pale yellowish-brown, dull dark olivaceous or purplish-brown, to black, more or less strongly streaked and intermixed with dull yellow. Three thin stripes of pale yellow extend along the dorsal surface through the thoracic shield to the anal extremity. The dorsal or middle line is nearly straight, and the subdorsal ones are feebly sinuate with the prominence of each segment. On each side there is a broad yellow undulating line, more or less strongly mottled with red, particularly in the vicinity of the abdominal legs. The ventral or lower surface is paler, varying from dull yellow to greenish, sometimes very

mental or Prodenia-like forms were represented chiefly by males. In response to inquiry as to whether this rule held good in series from other sources, Dr. John B. Smith wrote, under date of February 3, that such was not the case, and that there are some localities where only the dull forms have been found, and others where only bright forms are obtained, but that where the two forms occur together in one locality it is quite possible that the Prodenia-like forms may be mostly males. Both sexes, however, may be found in both forms.

strongly mixed with red. Even in the darkest forms the striæ shown in the illustration (fig. 2 *c*, *d*) can as a rule be readily made out. The striated appearance, however, is usually weaker than in the larva of the common army worm, and the larger and more prominent black piliferous tubercles and the hairs proceeding from them with which the body of the fall army worm is marked will alone serve to distinguish this insect from the army worm proper. In the latter the piliferous warts are minute and inconspicuous and the hairs so short that the body appears nearly smooth by contrast. The fall army worm is the smaller and slenderer and the entire body, including the head and cervical shield, is usually much darker.

An illustration of the army worm is presented at figure 3 for comparison.

The head also presents good characters for the separation of these two larvæ. That of the fall army worm is smaller in proportion to the length of the body, nearly black, and with a white inverted Y-shaped mark in front not possessed by the army worm. These differences may be easily recognized by comparison of the heads of the two species shown in figure 4 at *a* and *b*.

FIG. 3.—*Leucania unipuncta:* larva—about one-third enlarged (original).

FIG. 4.—*a*, head of larva of *Laphygma frugiperda; b*, of *Leucania unipuncta*—both enlarged (original).

The pupa.—As shown in the illustration (fig. 1 *e*), the pupa differs but little from that of the army worm, save in its smaller size. It is of the usual form and shining mahogany-brown color of cutworm pupæ, lighter when first transformed and darker when approaching maturity. The anal segment ends in a pair of minute spines. The spiracles and a considerable proportion of the integument surrounding them are larger and much more prominent than in the pupæ of the army worm, this character appearing to be sufficient to distinguish between the two species at this stage. The length is about five-eighths of an inch (13–16 mm).

TECHNICAL DESCRIPTIONS OF THE EGG AND LARVA.

[By Harrison G. Dyar, Ph. D.]

Eggs in a close double layer, one above the other, more or less covered with fine gray down from the moth; spherical, well-rounded, the base a little flatter than the apex, uniform; vertical ribs numerous, about 60, small, joined by distinct crossbars

nearly as large as the ribs themselves and forming rectangular or slightly hexagonal areas; above, the ribs do not diminish till near the vertex, where they become converted into reticulations, smaller toward the micropyle; color, pearly pink; diameter, 5 mm.

Stage I.—Head rounded, bilobed, about as high as wide, clypeus triangular, half as high as the head, without perceptible paraclypeal pieces; labrum quadrate and with the mandibles projecting; shining jet black; antennæ moderate, pale; setæ short, pointed; width .25 mm. Cervical shield straight before, rounded behind, jet black, bearing 4 setæ on each side; two more (of which one is scarcely visible) detached posteriorly, laterally; prespiracular and subventral tubercles single-haired; anal plate semicircular, dusky blackish. Body whitish, slightly translucent, tubercles large, round, black, with very distinct, short, black, pointed setæ. Arrangement normal, no subprimaries; on joints 3 and 4, ia and iia small, ib and iib large, all well separated and equally spaced; iv and vi single-haired; on the abdomen i, ii, and iii large, equal, i and ii on joint 12 approximately in a square, iv behind the spiracle and with v as large as the dorsal ones. Leg shields small, quadrate, black; ventral tubercles minute, also black. Feet of joints 7 and 8 slightly smaller than those of joints 9 and 10. After feeding the larva becomes green from the food.

Stage II.—Head round, slightly bilobed, shining black; width .4 mm. Body as before, a little thicker, and joints 12 more distinctly enlarged; cervical shield black; anal plate not cornified, pale like the body, shaded with gray on the sides. Color whitish, with faint traces of dorsal, subdorsal, lateral, and stigmatal lines. Tubercles large, black, and distinct as before, the subprimary ones present. Hairs short, stiff, black. Thoracic feet black, the others pale, with dark shields.

Stage III.—Head round, shining black, the sides covering the eyes and sutures of clypeus, pale luteous; width .65 mm. Shields and tubercles shining black, tubercles large, setæ coarse and black. Body greenish gray, dorsal and subdorsal lines whitish, straight, narrow, and even; ground color darker laterally, ending in a blackish shade touching tubercle iv, defined on the ventral side. A broad, pale, substigmatal band; subventer grayish green, shading to the scarcely paler venter. Body uniform, joint 12 very slightly enlarged.

Stage IV.—Head black, paraclypeal pieces and labrum pale whitish, sides no longer pale, but filled in with black mottlings; rounded, slightly bilobed, shining; width 1.1 mm. Cervical shield black, bisected, not strongly cornified; anal flap dusky; tubercles large, black. Body greenish gray, dorsal, subdorsal (at tubercle ii), and traces of narrow lateral lines pale, as before; substigmatal line broad, white, mottled with greenish and divided by a central band of this color. Feet dusky; setæ distinct, black, rather long.

Stage V.—Head rounded, slightly bilobed; clypeus large, the paraclypeal pieces nearly attaining the vertex; mandibles prominent; brown-black, sides mottled with pale, especially posteriorly, paraclypeal pieces white, as also the vertical suture; labrum pale, width 1.8 mm. Body cylindrical, normal, joint 12 very slightly enlarged, feet nearly equal. Above dark brown, a little dotted with pale, venter more greenish, but also brown mottled. Dorsal line pale, nearly obsolete except on the thorax and anal plate; subdorsal line distinct, white, straight, a little broken on joints 12 and 13; stigmatal band broad, sharply edged, not inclosing the spiracles, white, nearly filled in with dark red mottlings. Feet all dusky; cervical shield sooty black, not strongly cornified, cut by dorsal and subdorsal lines; anal plate dusky, with two white spots, formed by the broken dorsal line; tubercles distinct, black, with short, stiff, black setæ.

Stage VI.—Head rounded, bilobed, clypeus large, the paraclypeal pieces reaching three-fourths of the distance to the vertex; brown-black, sides posteriorly mottled with pale, sutures white, all as before; width 3 mm. Body as before, joint 12 very slightly enlarged, feet equal. Blackish brown above, varying in shade, the lateral

space tending to be darker, as also a space each side of the dorsal line; venter pale greenish, densely mottled. Dorsal line whitish, as broad as the subdorsal and regular, but much fainter; subdorsal line mottled with pinkish, straight. The pale mottlings of the body are heavier between tubercles i and ii and across tubercle iii, suggesting obsolete lines. Slight black streaks bordering the subdorsal line below. Substigmatal band broad, sharp, the edges a little irregular, white, filled in with pale red mottlings. Feet all dusky; cervical shield black, very narrowly cut by white dorsal and subdorsal lines; anal plate dusky, cut by pale dorsal line, with a constriction anteriorly. Tubercles cornified, distinct, dark brown, largest on joints 12 and 13; tubercle iv on joint 5 is opposite the upper corner of the spiracle, on joints 6 and 7 below the middle, on 8 at the middle, on 9 above the middle, on 10 at the upper corner, on 11 low down halfway between the spiracle and tubercle v, and on joint 12 opposite the lower corner of the spiracle. Setæ short, rather stiff, dark.

DISTRIBUTION OF THE SPECIES.

The distribution credited by Dr. Smith (Bul. 44 U. S. Nat. Mus., p. 168), taken together with divisional records of occurrence, shows that this insect is generally distributed from Canada and Maine south to Florida and the other Gulf States, and west to Colorado and Montana. It is known also in Jamaica, Brazil, and Cuba.

Judging by the locality list cited above, which was published in 1893, it would seem probable also that the insect has widened its natural range since that time, as it was stated to occur westward only as far as Kansas and Nebraska, and Maine was not included among the northern localities. It was troublesome about Chicago, Ill., for the first time in 1899, and recently has been reported by different entomologists from several northern regions. These include Kittery and Orono, Me. (reported, respectively, by Messrs. Thaxter and Slingerland), and St. Anthony Park, Minn. (Lugger). The most western locality in Montana is Miles (Davis), and in Colorado, Fort Collins (Gillette). The most northern locality in New York State is Number Four (Lintner).

This insect is undoubtedly native to North America as well as South America and indigenous to the United States. Its occurrence in Brazil and in Central America and its greater abundance in semitropical portions of the United States would indicate that it was originally, although not in very recent times, a tropical species. At present it is more at home in the Southern States, in the Lower Austral zone, where unusual opportunities are afforded for its increase in swamp land, among wild rice and rank grasses, but it is also thoroughly acclimatized nearly throughout the Carolinian portion of the Upper Austral zone, and appears to be gradually working its way northward, the extreme northern localities mentioned being located well within what is considered the Transition zone.[1] It is evidently destined to further invade

[1]The mere record of the capture of this insect in the most northern localities noted can scarcely, in the writer's opinion, be taken as positive evidence of its establishment there. It would seem more plausible that the insect had not bred in such

the Transition zone in course of time, although it will probably not be injurious much north of the Upper Austral for many years to come.

NAMES OF THE INSECT.

Few native species of insects have had applied to them a greater variety of common names. Beginning with the first name proposed by Smith and Abbot of corn-bud-worm moth, we have grass worm and grass caterpillar applied in the fifties, and in later times wheat cutworm, army cutworm, grass worm, southern grass worm, army worm, fall army worm, Daggy's corn worm, and grass army worm. To this list was added during 1899 by Nebraskans "alfalfa worm," and by Floridans "buck worm."

The scientific nomenclature includes: *Phalæna frugiperda* S. and A., *Trigonophora frugiperda* (Geyer), *Laphygma* (misspelled *Laphrygma*) *frugiperda* (Guenée), *Laphygma signifera* Walk., *Prodenia autumnalis* Riley, and *Laphygma macra* Gn. (misspelled *machra* by Glover).

REPORTED OUTBREAKS IN 1899.

In addition to the outbreaks which will be here recorded it should be said that the list of localities, although considerable, by no means shows the extent of the ravages of this pest. Many correspondents reported "*the* army worm" in their vicinity, and many requests were received for circulars of information concerning the army worm where there was little doubt that the fall army worm was the species concerned.[1] No specimens of the insect were received from many such correspondents; hence the list of localities, which would considerably augment that which will be presently given, must necessarily, for scientific accuracy, be omitted.

The first reported instance of injury during the season of 1899 was from Mr. M. Cronly, who wrote, June 19, of damage to the rice crop in the vicinity of Wilmington, N. C. Specimens accompanied this letter, as also all other reports which will be here cited.

July 6 Mr. W. T. Hopkins wrote that this species was present in large numbers at Cherry, N. C., doing much damage to corn, rice,

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localities, but had flown there from farther south. We know this to be the case with the cotton worm, which is sometimes to be found in great numbers in New York, and even in Canada, while there is no reason for believing that it breeds farther north than the northern border of the cotton belt; in fact it is almost certain that it does not breed north of there. It is possible, also, that the fall army worm dies out every year or two in the coldest localities in which it breeds, owing to the rigors of winter weather, but is restocked in after years.

[1] *Leucania unipuncta* was received with reports of injury during the year 1899 only from single localities in each of four States, Kentucky, South Carolina, Louisiana, and Virginia.

peas, and grass, extending its depredations over a considerable territory and in some places completely consuming young corn. It was impossible to use Paris green at this time, as the corn was too tall for the purpose, and the larvæ were, moreover, all over the ground and over all vegetation in the neighborhood.[1]

During the latter half of July the writer observed this insect in considerable abundance in the unfolded leaves and young ears of corn at Marshall Hall, Md., and in great numbers on grasses in the experimental plats of the Department grounds, being particularly injurious on the creeping bent (*Agrostis stolonifera*), which it practically destroyed.[2]

During August many reports of injury were received. The first was from Mr. C. A. Hart, Urbana, Ill., who sent larvæ found at Arcola, in the same State, feeding on leaves of corn. On the 5th Mr. E. D. Sanderson brought larvæ received from Mr. A. T. McCallum, Red Springs, Robinson County, N. C., with report that they were injuring corn, millet, sweet potatoes, cowpeas, and other vegetables at that place. On the 22d Mr. W. H. Stennett wrote concerning this species, inclosing a clipping from a Chicago daily, and reporting the appearance of the caterpillars simultaneously at Chicago and at Evanston, Ill.[3] Injury in Chicago was most marked upon lawns; larvæ were also observed to attack white clover, and were noticeable on young blue grass.

August 24 Mr. Adam Wechsler, New Glatz, Prince George County, Md., brought larvæ that were ravaging a field of sowed corn in that vicinity and were spreading into a field of spinach. Mr. Wechsler expressed the belief that he would probably lose both crops. The same day Col. Wright Rives, Rives, Md., reported attack on millet at his place, the insects being so abundant as to cause fear that they

[1] Our correspondent stated that it had been very wet in his vicinity all of the preceding year and until late that spring, after which the rain had been very light and insects of various kinds had been unusually troublesome, but what bearing those conditions could have had on the enormous numbers of the insects is not obvious.

[2] A feature of this latter outbreak was that injury was at first believed to be due to the work of the sooty corn-root webworm (*Crambus caliginosellus* Clem.), the only insect that could be found July 17, when the attention of the writer was first called to the injury. A small grass-feeding billbug, *Sphenophorus parvulus* Gyll., was also present in large numbers and in all stages, as was also a minute wireworm, *Monocrepidius bellus* Say. Specimens of white grubs in the first stage (*Lachnosterna* spp.) were also taken. Injury was undoubtedly due mainly to the fall army worm, although the root webworm and billbug were also in sufficient numbers to make their presence felt. This is a good example of what is often to be found where only a single species is reported as responsible for injury.

[3] From Mr. Stennett's letter and from the newspaper account it appears that this invasion of caterpillars was preceded by one of the milkweed butterfly, *Danais archippus* (*Anosia plexippus*), which species was described as descending in a cloud in certain parts of the city.

would destroy the entire crop. The following day Mr. Charles Deering, of Chicago, Ill., wrote concerning the outbreak previously noted in that city and suburbs. The grass upon his own lawn, of perhaps 2 acres, seemed quite dead in parts that lay mostly in the sun. The same day Mr. Joe V. Walz, Evansville, Ind., wrote concerning an attack of this species on corn in his vicinity, the farmers there complaining that this was a new species of corn worm. It was described as attacking and boring into the center of the stalks and eating out the heart. August 29 we received a telegram from the Evanston Press, Evanston, Ill., stating that the army worm was destroying lawns in that city. Request was made for information for publication, and the reply by the writer, who was at that time in charge of the Division, was published in the Evanston Press for September 2. The same day word was received from Hon. G. W. Koiner, Richmond, Va., that this species was destroying corn and millet near that city. On the 31st of August Dr. W. W. Anderson, Statesburg, S. C., wrote that these caterpillars were eating up the grass and destroying the hay crop, as well as garden vegetables, all over the State. The caterpillars were said to be much more numerous than usual.

September 7 we received specimens from Dr. A. D. Hopkins with information that the species was destructive in lawns in Morgantown, W. Va. The following day Mr. H. Meislahn, Clarcona, Fla., reported that this insect, locally known as "buck worm," was attacking "Teosinte" (*Euchena mexicana*), a useful graminaceous forage plant resembling Indian corn. The same day Mr. W. K. Westone, Congaree, S. C., reported that it was very destructive to upland rice in that vicinity. It was stated that the habit of the larva was to attack the foliage of the rice in its tender state, afterwards eating the heads and destroying the grains. September 11 Mr. G. L. Grant, editor of the Florists' Weekly Review, Chicago, Ill., sent specimens of the egg masses, together with moths, with the report that the eggs had been deposited in large numbers on the side of a stone wall. The moths had also invaded a greenhouse and covered the plants with eggs.

October 4 we received from Mr. Thomas I. Todd, Athens, Ga., larvæ of this species, together with others found injuring the leaves of the turnip crop of that vicinity. Later he wrote that the "worms" were so numerous as to almost cover the public roads. Nearly all when observed were traveling west or southwest. On the 13th we received larvæ from Mr. Warren Knaus, McPherson, Kans., with the statement, conveyed in a letter of October 17, that they were very destructive to growing wheat near Conway, Kans. October 28 Mr. J. C. Vida, mayor of Camajuani, Matanzas, Cuba, sent specimens with the report that this species was concerned with two other caterpillars, both evidently native to Cuba and unknown to us, in a severe attack upon pasture land as well as young tobacco.

November 4 Dr. E. P. Felt, Albany, N. Y., reported, on the authority of Mr. M. F. Adams, that there had been injury to lawns at Buffalo, N. Y.

In January, 1900, Mr. Webster informed the writer that the fall army worm had been injurious in Ohio the previous fall, and named Haverhill, Scioto County, Buck Run, Adams County, and Urbana, Champaign County, as localities in that State where the insect had been reported in destructive numbers.

February 3, 1900, Prof. J. B. Smith wrote that this insect had been injurious in New Jersey the previous season and for the first time in his experience. It attacked clover, grass, and wheat.

The fall army worm became the subject of some newspaper comment, and quite a number of newspaper paragraphs, in addition to those which have been cited, appeared in reference to the pest, particularly in Chicago dailies. In one of these the insect was identified as the boll worm, *Heliothis armiger*, and the "kissing bug" was stated to be an effective destroyer of the "worms." In some instances injury was confused with that of certain caterpillars which infested fruit and shade trees. In some other journals published farther west, however, the ravages of this insect were noticed, and the identification vouched for by entomologists.

According to Press Bulletin, circular series No. 2, University of Nebraska, by Prof. W. D. Hunter, which reached the writer after the reports previously recorded, injury was very severe in that State, particularly to alfalfa, whence the name "alfalfa worm," which became very generally applied to the caterpillars. The species was identified from Johnson, Gage, Nemaha, Saline, Fillmore, Douglas, Washington, and Dodge counties, and was also reported from Boyd and Dawson counties. In some localities the alfalfa fields suffered the loss of the third cutting. Many beet fields were attacked, also those of corn, Kafir corn, wheat, oats, cabbage, and grasses. Cowpeas, millet, and other general and truck crops, according to Prof. E. D. Sanderson, were infested in that State.

The editor of the Indiana Farmer stated in his issue of September 2, 1899, that the fall army worm was reported in the corn fields and gardens within 4 miles of Indianapolis in large numbers. In a subsequent issue, September 9, it was reported on the authority of A. C. Harvey that this insect had made its appearance at New Lafayette, Ind. The larvæ started from a piece of oats ground which had been plowed up for wheat; the army had crossed into a tender millet patch and devoured it, and was at the time of writing in buckwheat.

In the Ohio Farmer of November 2, 1899, complaint was made by a correspondent of injury to wheat by this species at Haverhill, Ohio. "The worms" were doing much damage, taking "the fields clean as they go." An answer to this letter was given by Mr. Webster, with short notes on the insect's habits and suggestions as to remedies.

A list of localities where injuries were noticed in the State of Illinois during 1899, together with a short general account of this species, was given by Messrs. Forbes and Hart in Bulletin No. 60 of the University of Illinois Agricultural Experiment Station (pp. 497, 498, 1900). The actual localities in Illinois where attack was observed include, besides Chicago and its suburbs, Quincy, Meredosia, Arcola, Urbana, Villaridge, and Champaign.

A brief report of the occurrence of the fall army worm in Nebraska in 1899 was given in the Thirteenth Annual Report of the agricultural experiment station of that State (1890, pp. 47, 48). The actual list of localities infested included Tecumseh, Beatrice, Crete, Hastings, Fremont, Northbend, Gothenburg, and Butte, and the crops infested included alfalfa, sugar beets, rye, white clover, and blue grass. At Northbend and Gothenburg the "worms" were reported as destroying grass growing on lawns.

Writing May 12, 1900, Mr. N. L. Willet, Augusta, Ga., stated that this species was injurious in that locality the previous summer, doing a great deal of serious damage, principally to velvet beans grown as a forage crop. On the 19th of the same month Mr. G. G. Hood, China Spring, Tex., reported this species in his vicinity. He stated that this insect, with the common army worm (*Leucania unipuncta*), specimens of which he sent, had been present in his section the preceding year after a rainfall of 30 inches the first of July. They stripped the alfalfa fields and did considerable damage to wheat, young corn, and sorghum.

OCCURRENCE IN 1900.

Stranger still than the occurrence of the fall army worm in 1899 was its apparent nearly complete disappearance the following season. Up to September 17, when the writer captured a single moth at a light in this city, no word had been received from any of our correspondents of the occurrence of this insect, in spite of numerous inquiries in regard to it. In all perhaps upward of seventy people had been written to in regard to possible injurious occurrences in 1900, and, although many of our correspondents were good observers, the insect was not seen by them.

October 12 we received information from Mr. W. R. Beattie, of the Division of Botany, that an insect which he had mistaken for the boll worm was doing great damage to corn on the Potomac Flats, near the Department of Agriculture. The species concerned in the injury proved to be *Laphygma frugiperda*, present in all stages at this time and in the greatest abundance, the corn plat infested being a complete ruin. The fact had first been noticed about the middle of September, but from the appearance of the leaves and stalks it was obvious that the insects had begun work a little earlier. Another and an unrecorded food plant was observed—the chick-pea (*Cicer arietinum*), which was

being grown experimentally in a near-by plat. All of the pods of the last-mentioned crop were empty, and in some cases larvæ of this species were present in them, though the principal damage was doubtless due to the boll worm or corn-ear worm (*Heliothis armiger*), which was also present.

Attack was noticed in the same locality also to crab-grass, rutabaga, hollyhock, and lambsquarter (*Chenopodium album*).

In Bulletin 186 of the Michigan State Agricultural College Experiment Station, bearing date of December, 1900, and issued in 1901, page 30, Mr. R. H. Pettit makes mention of a similar small outbreak of this species at Chatham, Alger County, Mich., on corn, which he states was badly affected upon the station grounds, the insect entering the ear and burrowing into the kernels, both when they were in the milk and later, in the same manner as is done by the corn-ear worm.

OCCURRENCE IN 1901.

In 1901, Mr. Darden Edgar, Edgar, Dewitt County, Tex., sent larvæ, which were about three-fourths grown at the time of their receipt, May 4, which he had found attacking stalks of young corn in the usual manner described in previous accounts of this species. Some were found in the "buds" and some in the stalks. The species had not been noticed in that locality in previous years by Mr. Edgar, who is a good observer, and although the larvæ did not occur in great abundance in that vicinity at the time of writing, it seems quite probable that this occurrence is a precursor of more severe attack and that a later generation may do serious damage in the Southern States, at least locally, and that the insect may even spread northward to regions where it was destructive in 1899.

Mr. W. J. Young also wrote in regard to injuries in Louisiana, stating that the insect was noticed nearly every year, but had not been so destructive since 1882 or 1883. It was noticed in several different parts of a field where the larvæ had literally eaten the leaves off of 40 acres of sugar cane ranging from small shoots to cane 2 feet high. A piece of corn just tasselling was cleaned of every leaf, and in 20 acres of young corn they ate the entire heart or "bud" out. They burrowed into a great many stalks of corn at the first and second joints from the ground, disappearing into the stalks. The ground was described as being at this time "just full of them changing from the worm to the moth." Some neighbors complained of the same trouble, and on some plantations where there was nothing growing but cotton the worms ate that. August 25 our correspondent sent specimens of the moth from Whiteville, La., with report that the larvæ had apparently disappeared entirely at this time. The cane, however, was permanently injured. About 60 per cent of the wrapper blades were dead

to the ground, but the lower eyes on the cane had sent out sprouts, showing an entire deterioration of that part of the stalk.

August 24 Mr. Sam. P. Saltus wrote of injury by this species, stating that it did much damage in the vicinity of Gillisonville, S. C., to grass intended for hay. In a patch of 4 acres sown in peas, also to be cut for hay, all the grass was destroyed in about two days, but the pea vines were left untouched. The same was noticed in fields of cotton.

HISTORY AND LITERATURE.

The original description of the fall army worm appeared in Smith and Abbot's Natural History of the Lepidopterous Insects of Georgia (1)[1] in 1797, or one hundred and two years before the time of the last general outbreak. Even at that early date it was recognized that the species was a very destructive one, Guinea corn and other kinds of grain being then known as food plants, the larva being stated to feed on the bud or main shoot of the plant within which it lives. This account, which includes suggestions as to remedial treatment, is illustrated by a colored plate showing the different stages and the two common varieties of the adult.

The economic literature of this species is very considerable and an effort will therefore be made to confine references to such publications as bear upon the history of outbreaks of the insect or upon its life history and habits.

It was not until the year 1855 that the insect appeared to have again attracted attention by its ravages, although there can be no doubt that it was injurious from time to time in different portions of the Southern States during that period. In that year Townend Glover, in his report on cotton insects (3), gave a fair account of this species, paying particular attention to ravages in the State of Georgia in 1854. Mention is made also of injury in 1845, reported by a Colonel Whitner at Tallahassee, Fla., to grass, corn, sugar cane, and upland rice. Glover's notice of injury refers particularly to grass, young grain, and cotton, and he stated, among other things, that "instances had been known in which these caterpillars, urged by necessity, actually devoured stalks of fodder that were stored away for winter consumption. Deep ditches cut in the earth to stop them were immediately filled up by the multitudes which fell in and perished, while eager millions still rushed over the trembling and half-living bridge formed by the bodies of their late companions, bent on their mission of destruction and devastation."

During the year 1868 three accounts appeared by Joseph B. Lyman, M. D. Landon, and the late C. V. Riley. The account of the first

[1]The numbers in parentheses ( ) refer to corresponding numbers in the bibliographical list appended.

writer appeared in Cotton Culture (4), the species being designated as "the army worm." The illustration furnished, however, shows that *Laphygma frugiperda* was the insect under discussion. The account of the second author mentioned is made under the head of "The grass caterpillar," and refers to the now well-known habit of this larva of being frequently found in cotton fields, where it does little damage, provided weeds, grasses, or other vegetation more palatable to it are present for it to feed upon. He states that the insect was the source of much amusement on his plantation of Helena, Ark., during 1867. The gist of the story is that Mr. Landon was congratulating himself upon having the grass and weeds devoured by this insect in his cotton field, when to his disappointment no sooner had the grass worm finished its mission and left the rows clean than the cotton worm made its appearance, presumably in great numbers, although this does not appear clear from the published statement. Dr. Riley's first account was published in his first report as State entomologist of Missouri (7) under the name of "Wheat Cutworm." Injury was noted to wheat, oats, and grasses and only in the State of Missouri.

In succeeding years Dr. Riley reported injuries in various localities. In 1870 (American Entomologist, Vol. II, p. 43), in joint authorship with B. D. Walsh, he made brief mention of this species, proposing for it the name *Prodenia daggyi*, but without description. Subsequently (l. c., p. 329) he made mention of ravages by this insect in many parts of Missouri and Illinois during that year, and furnished figures of the larva. Later (l. c., p. 340) mention was made of injuries at Ottawa, Kans., and Eureka, Mo., and still later (pp. 363–365) the moth was figured and described in detail under the name *Prodenia autumnalis* in a fuller account. The last two articles mentioned were incorporated in one in the Third Missouri Report, published in 1871 (12).

In Glover's report, as Government entomologist for 1872 (13), brief mention was made of injury during that year by this insect to corn, grass, and pea crops in Georgia.

In 1878 Dr. Cyrus Thomas (16) gave a short account of this species, referring to an outbreak in about the year 1873 in Washington County, Ill., when "sad havoc" was done to winter wheat.

In the year 1881 Dr. Howard visited the rice fields in the vicinity of Savannah and Atlanta, Ga., and Columbia, S. C., where injury was noted to other crops than rice, larvæ being observed eating grass, cabbage, strawberry, and bean plants. At this time remarkable evidence of cannibalism was noticed, in one locality the older worms destroying the younger ones by hundreds, and this when plenty of other food was at hand (23).

In 1884 there was a considerable outbreak in Illinois, as described in detail by Prof. S. A. Forbes in his report as State entomologist for

that year (27), and in Kansas as reported by Prof. F. H. Snow (26). The first-mentioned account is the most complete published to date, and includes a revision of the literature, description of the different stages, observations on the life history, natural enemies, and a consideration of preventives and remedial treatment.

The occurrence of this species in 1885 and 1889 at Lafayette, Ind., was noted by Prof. F. M. Webster in 1890 (30).

In 1892 an outbreak in Louisiana was brought to the attention of Prof. H. A. Morgan, of the experiment station of that State (38). Corn and pea crops were destroyed that year by immense numbers of the caterpillars, particularly along the Black and Ouachita rivers.

The species was unusally abundant and destructive during the autumn of 1896 and in the late spring and early summer of 1897 in Florida, and was the subject of a six-page bulletin by Mr. A. L. Quaintance, at that time entomologist of the experiment station of that State (44).

Mr. Hunter's press bulletin, which bears date September 23, 1899 (47), on this insect has already been mentioned, and subsequent accounts which have not been referred to will be duly cited in the bibliographical list which concludes the present article.

DIVISIONAL RECORDS OF INJURIES AND OCCURRENCES.

The Divisional records of injuries by the fall army worm prior to 1899, showing the wide distribution and great injuries done by the insect, are extensive, though somewhat incomplete in the earlier notes made.

December 5, 1878, Mr. William J. Jones, Virginia Point, Tex., mentioned the occurrence of this species in his vicinity, but with no notes as to injury. The same is true of the receipt of specimens of the eggs, January 27, 1880, from Prof. J. H. Comstock, taken at Jacksonville, Fla.

August 27, 1881, we received larvæ from Dr. Howard, from Savannah, Ga., with report that there were millions of them crawling about in the vicinity at that time. August 29, Dr. Howard sent material from Columbia, S. C. October 22, we received complaint from Mr. D. H. Bradley, Pickens Court-House, S. C., of what was with little doubt this species, and of injuries to fodder, cotton, grass, etc. November 12 of the same year we received larvæ from Mr. George E. Ladshaw, Pacolet Depot, Spartansburg County, S. C., with report that this insect damaged corn in that vicinity.

September 11, 1883, we received specimens from Prof. J. E. Willet, Macon, Ga., with the report that they were observed on Bermuda grass, *Cynodon dactylon*, and had nearly denuded three-fourths of a bed of turf.

A considerable outbreak of the fall army warm occurred during 1884, as evidenced by Divisional as well as by published records. During May of that year we received caterpillars from Prof. A. J. Cook, Lansing, Mich., with report that they were doing fearful damage in parts of that State, "eating everything," and being often so thick that when walking over a meadow from a dozen to a hundred would be killed at each step. Subsequently we received another lot of material from the same source of what proved to be the black cutworm or erratic army worm (*Noctua fennica* Tausch.), which was evidently the principal species causing the injury referred to. August 9 we obtained moths of this species from eggs collected in the District of Columbia on the leaves of hickory. August 15 we received larvæ from Judge Lawrence C. Johnson, Holly Springs, Miss., with the statement that they injured the stalks of corn in that vicinity. August 19 larvæ were received from Mr. R. W. Jones, Oxford, Miss., who wrote that they were devouring all the grass in that vicinity. September 17 we received material from Mr. F. M. Webster, Oxford, Ind., the insect being reported injurious to young wheat. October 11 we received from Mr. E. W. Allis, Adrian, Mich., specimens with the report that the insects were doing considerable damage to early sown wheat. October 16 caterpillars were received from Mr. Eli C. Fisk, Havana, Ill., who stated that they were doing immense damage to young wheat, hundreds of acres having been destroyed at that time.

October 10, 1885, Mr. Warren Knaus, Salina, Kans., wrote that these larvæ were eating up the rye and doing apparent damage to wheat in that vicinity. November 20 of the same year we received from Mr. F. M. Webster specimens of this insect in all stages, bred from volunteer corn at Lafayette, Ind.

November 21, 1888, we received specimens of the eggs on a section of lemon leaf from Mr. C. J. K. Jones, Louisville, Ky., and November 18 of the next year we received from Mr. F. M. Webster specimens with the statement that they were feeding on corn. Both of Mr. Webster's notes are recorded in Bulletin 22 (o. s., p. 46).

October 11, 1893, Prof. R. H. Price, College Station, Tex., sent larvæ with the report that they were crawling over the ground by the million and eating "nearly everything."

No further reports of injury were received until 1897, when Mr. Cyrus W. Butler, St. Petersburg, Fla., sent larvæ early in July, where they were eating the leaves of sandspur grass and crawling about rapidly, as is their wont, in search of other food. It was observed that they did not touch beggar weed growing among the grasses. August 9 we received from Miss Louise Morris, Athens, Ga., larvæ with report that they were destroying violets and that thousands were observed in the surrounding grass. August 27 Mr. Charles H. Willson, Longridge, Berkeley County, S. C., wrote concerning this

species, with the statement that it had appeared suddenly in the cornfields of that neighborhood and had eaten the grass clean; corn had not been injured to any extent, and at the date of writing the larvæ had disappeared. September 11 and 12 Mr. Orris A. Browne, Cape Charles, Va., wrote of injury to Scotch kale, stating that the insects, specimens of which he sent, and which included both this species and the common army worm, had gone over 20 acres of his crop.

The adult of this species issued during the third week of October from larvæ received from Mr. P. H. Dorsett on greenhouse violets at Garrett Park, Md., September 20 and 29, 1898.

REVIEW OF REPORTED OUTBREAKS.

Although in many years outbreaks were noted only in a single State, there is reason for believing that, in the earlier years particularly, injury was much more extensive than reported. A review of recorded outbreaks and those reported to this Division show injury in 1845 in Florida; in 1854 in Georgia; in 1866 in Kansas; in 1868 in Missouri; in 1870 in Missouri, Kansas, and Illinois; in 1872 a second irruption in Georgia; in 1873 a second outbreak in Illinois; in 1874 an irruption attributed to this species in South Carolina, Georgia, and Alabama; in 1881 a third outbreak in Georgia, and a more extensive one in South Carolina, from which we may conclude that Florida was probably also invaded at the same time. In 1883 still another invasion of Georgia was reported, and in 1884 we have record of the first known outbreak of any extent. The insect was noted that year in Michigan, Illinois, Kansas, Indiana, and Mississippi. The following year it made its appearance in destructive numbers in Kansas, and its occurrence was noted also in Indiana. In 1892 injury was noticed in Louisiana, and the following year in Texas. In 1896 an irruption occurred in Florida, and the following year again in that State, as also in Georgia, South Carolina, and Florida, injuries being particularly severe in the last mentioned State; but there is reason for believing that the outbreak was more extensive than reported, since small armies were noticed that year by the writer in the vicinity of the District of Columbia, indicating the probability of injurious occurrences between here and the Southern States.

The outbreak of 1899, as may readily be gathered by the perusal of the preceding paragraphs, was of greater severity than ever before noticed, and, judging by reports, perhaps as extensive as all other known injurious occurrences of earlier years combined. To briefly summarize the occurrences of the year 1899, it will be seen that irruptions were noted in the East and North from western New York westward to Indiana, and northern Illinois southward to Florida and Georgia and probably the remainder of the cotton States, westward again to Kansas and Nebraska. Complaints also reached us from Cuba.

In 1900 two comparatively small outbreaks of this species were observed at Washington, D. C., and at Chatham, Mich., as previously reported. In 1901 to date of going to press injurious occurrences have been reported in Texas, Louisiana, and South Carolina.

FOOD PLANTS.

Grasses, as previously stated, are the preferred and evidently original food plants of the fall army worm, but when the caterpillars have bred in unusual numbers and have exhausted the grasses and are traveling in armies in search of new food they are less discriminating in taste, being able to subsist on nearly any kind of succulent vegetation that may be encountered in their line of march, including even the leaves of trees.

Cereals are next in order after grasses as larval food plants, corn being a prime favorite, while rice, wheat, rye, oats, millet, and Kafir or Guinea corn are often severely injured. Barley, for some reason, does not appear to have suffered much from attack. The "worms" are especially fond of young and tender grasses and grains, and infestation is more frequently noticed on newly planted winter wheat and other cereals following grasses or cereals in rotation of planting. Crowfoot and crab grass are noted as favorite grasses in the South, and millets are much affected everywhere. Creeping bent was preferred to any other plant on the Department of Agriculture grounds in 1899.

It is apparent that the species has become, perhaps from periodical overmultiplication necessitating frequent migrations, somewhat of a general feeder even in nature. Among other field and forage crops injury has been noted to sugar cane, buckwheat, alfalfa, clover, cowpea, chick-pea, velvet bean, sugar beets, cotton, tobacco, and teosinte (*Euchena mexicana*). Few instances are on record of the caterpillars subsisting to any extent upon weeds other than Gramineæ. Purslane is mentioned as a food plant by Riley (8th Mo. Rept., p. 48).

Attack on cotton has frequently been noted, but according to observation this is scarcely a favorite food. The insects merely attack cotton when grasses or cereal crops in the immediate vicinity have been consumed, seldom effecting much damage. Grasses growing between rows of cotton and other crops are often attacked, and the insect in such cases can be considered as rather beneficial than otherwise, provided its numbers are not such as to exhaust this food and drive it to attack useful plants.

Pea vines among garden vegetables constitute a choice food, and we have records of injury to sweet potato, spinach, turnips, tomatoes, potatoes, cucumbers, cabbage, beans, and strawberries.

Vineyards are also subject to attack, the larvæ having been noticed

doing great damage by gnawing around the stems and causing the bunches of grapes to fall.

Of fruit trees, attack to the foliage of peach, apple, and orange is recorded, and egg masses have been taken on the leaves of lemon, hickory, and sycamore. Riley has stated that even spruces are subject to attack. Of its occurrence on fruit trees, Hubbard (in speaking of its feeding on the orange) says that "although the young caterpillars eat the leaves to some extent, they soon find their way to some other and more succulent food plant." It is obvious, therefore, that the feeding of the fall army worm on the foliage of trees is quite exceptional, and due usually to the fact of the eggs having been deposited on the leaves of the trees, since mature larvæ are scarcely if ever seen on trees. There is a possibility that the maturing larvæ may attack the leaves of the trees when driven to it through scarcity of other food, but this is doubtful, since these larvæ prefer low-growing plants.

It would seem probable that it might be a matter of common occurrence for the species to invade greenhouses when unusually abundant on grasses and other vegetation in the vicinity, but our records show only injuries to violets among hothouse plants.

Instances of extreme foods are to be found when stacks of fodder are attacked, as instanced by Glover (5), previously mentioned.

It is not alone the leaves of plants that are injured, as was known in Smith and Abbot's day upward of a century ago. The caterpillars delight in eating into the hearts of their food plants, cutting into the still folded leaves of corn and even boring into the ears after the manner of the boll worm or corn-ear worm (*Heliothis armiger*),[1] devouring alike husk, silk, and unripe seeds.

OBSERVATIONS ON THE LIFE HISTORY.

The life history of the fall army worm, as previously intimated, has not yet been studied as carefully in any single locality as its importance as a pest deserves. Even the stage or stages in which the insect passes the winter were in doubt until 1900.

HIBERNATION.

That it did not hibernate in the egg condition in the latitude of the District of Columbia was proved by the writer in 1899. During September of that year we had under observation great numbers of egg masses on grasses and on the walls of buildings in the vicinity of grass, and every mass hatched. A lot which was kept in our insectory under

[1] Like the boll worm and some species of cutworms, the fall army worm is inclined to be carnivorous at times, and even cannibalistic, devouring larvæ smaller than itself, and thus attacking its own species.

conditions suitable to the development of most insects, and which hatched from eggs deposited September 16, died after descending into the sand and while still in the larval condition. Another lot of larvæ received October 4 from Athens, Ga., gave forth adults during the second week of November. The consensus of opinion of writers on the subject is that the insect probably hibernates as pupæ, with a smaller percentage of individuals passing the winter months as adults.

A large number of larvæ were obtained from the field and divided into two equal lots, one being placed on grasses and weeds on the Department grounds, and confined by means of a large cover. The remainder were placed upon sand in a large rearing cage having the same sized cover and kept out of doors, where they were fed on fresh grasses and weeds from day to day. About a dozen of the second lot died while feeding, as a result of a cold spell with rain, which lasted for some little time, and the remainder, as far as could be ascertained, all perished as pupæ in their earthen cocoons before transforming to moths. Similarly, the lot placed on the ground transformed and entered the earth, but no moths issued.

It is practically proved that all egg masses deposited late in autumn produce larvæ, and in the most northern limits of the insect, where cold weather sets in much earlier, it is probable that of these larvæ only a very small percentage survive the average winter, and that the latest appearing generations in northern localities are the progeny, at least in many instances, of moths which have developed in, and migrated from, more southern localities earlier in the season.

From experience with four lots of the fall army worm under varying conditions and in different soils, the following deductions have been made in regard to pupation:

PUPATION.

When full grown the larvæ enter the earth to a depth of from a quarter of an inch to not more than an inch and a quarter, the average appearing to be about half an inch, the depth not varying at all according to the brood or the season, those transforming to pupa in late October and early November doing so at the same depth as others observed in August and September.

Pupation of all individuals observed in early fall occurred in little earthern cells, which were nearly erect or more or less inclined, the head in all cases being nearest the surface, and those observed in compact earth had smooth walls, made by the constant revolving of the pupa within; but occasionally pupæ were not thus protected. Most individuals which came under observation in cool October weather, and representing a later generation—in short, the last that can be produced in a region as cool as the District of Columbia—spun up more or less substantial cocoons of earth, lining them with an unusual

amount of silk (for a Noctuid), from which fact alone it might be surmised that hibernation took place within them as pupa, even did we not know, as previously stated, that all eggs that have come under notice hatched during the fall, and sufficiently early to permit of the larvæ reaching full development.

Prof. F. M. Webster writes, May 13, 1901, that he had a similar experience with this insect, meeting with no better success in rearing the moth. He placed a large number of larvæ in a breeding cage, saw them feed and then go into the ground, but from that time onward they seemed to have totally disappeared, "as though an earthquake had swallowed them up." He further states that the records of the Ohio station do not show that this species was ever reared to the adult.

These experiences, it seems to the writer, are proof conclusive that the species, being a Southern one, is unable to withstand our winters and our sudden changes. It seems equally certain that hibernation takes place exclusively as pupa in a climate like that of Wooster, Ohio, and the District of Columbia and northward, since it is hardly to be supposed that a Southern species could survive the rigors of a Northern winter in the moth state.

NUMBER OF GENERATIONS.

The number of generations produced annually has been stated to be at least two (possibly three for central Illinois, according to Forbes), and three for the South. The number will vary according to climate and season, and the writer surmises that at least three generations are produced in a climate like that of the District of Columbia, and that four or more may develop farther south. This is a matter requiring investigation, particularly in the Southern States.

SUMMARY OF LIFE HISTORY.

Our limited knowledge of the life history of the fall army worm makes it impossible to present a complete summary, but the hypothetical life cycle is about as follows:

It has been stated that larvæ of the first generation appear in May and June (locality not mentioned), and this statement is undoubtedly true for some regions. The earliest appearance of the moths in any single locality does not appear to have been recorded, or if it has it has escaped the writer's observation.

The period of the egg has been ascertained only for October in moderately cool weather, and it is ten days. This period will vary according to temperature during the period of incubation.

The larval and pupal periods of the different generations remain to be observed, but the former we know must be subject to extreme variation and the latter will, judging from analogy, not be much

different from the periods, that may in the future be observed, for the egg where pupæ and eggs are subject to the same atmospheric and other conditions.

Present knowledge indicates that the number of generations that are normally produced each year is two in the most northern range of this species (in years when it develops northward), three for central localities like central and southern Illinois and the District of Columbia, and probably four for the extreme South. We know, however, practically nothing of the development of this species in the Gulf States.

Hibernation, according to recent observations in the District of Columbia, takes place exclusively in the pupal state, and it seems probable that this is so elsewhere. The reasons for this statement are that eggs deposited in late autumn have invariably hatched, and that pupæ kept in the nearest obtainable natural conditions have not developed moths during winter. In a more favorable environment farther south hibernation would, without much doubt, have been successful, and the moths would have issued early in spring. Furthermore, had moths been obtained during winter from material under our observation it does not seem within the bounds of possibility that any would have sustained life in our variable climate.

NATURAL ENEMIES.

It has been stated with reason that there is perhaps no prominent injurious insect, at least none of the periodically destructive species, in whose economy natural enemies play so important a part as the common army worm; and this is to a certain extent true of quite a number of other pests with similar habits. It was natural to expect, therefore, that the fall army worm might, at least in its latest appearing generations, fall a prey to some natural enemy. For some reason, however, these natural checks did not materialize to any extent, at least with the exception of birds they were not at all active during the year of this outbreak in the vicinity of the District of Columbia. A different condition of affairs, however, obtained in some other localities.

ENEMIES OBSERVED DURING 1899.

Soon after the outbreak of caterpillars was first noticed on the Department grounds in 1899 a few English sparrows were observed on the infested plats; their numbers increased daily, and there is no doubt that in this particular place they depleted to a very considerable extent the numbers of this insect as well as of the others which were concerned in the injury. The sparrows were actually observed by Dr. Sylvester D. Judd, of this Department, in the act of devouring the larval fall army worms.

In a Chicago newspaper clipping received in August mention is made of an "outbreak of sparrows" in one portion of Chicago where they were attracted in thousands by "grub worms." It seems probable that they were also destroying fall army worms which were ravaging the lawns in that city at the time.

September 1 Mr. Deering, of Chicago, wrote that the larvæ had nearly all disappeared at that time, evidently having gone into the ground, and that birds, especially flickers, were very efficacious in lessening the numbers of the pest.

Among larvæ that were received at this office from Rives, Md., were a few that were parasitized, as was shown by the eggs of a Tachinid fly present on their bodies on or near the thoracic segments. From these the adults were obtained from the 4th to the 9th of September, and were identified by Mr. Coquillett as *Winthemia quadripustulata* Weid.,[1] or red-tailed tachina fly, a species of wide distribution in the United States and Europe and a well-known parasite of this pest. During the fall of 1884 at least 50 per cent of the larvæ collected in Illinois showed the eggs of this parasite.

This Tachina fly is figured herewith (fig. 5).

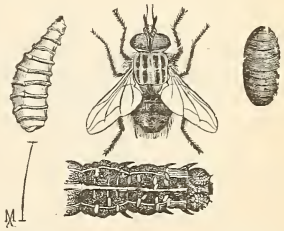

FIG. 5.—*Winthemia 4-pustulata* fly, with larva at left and puparium at right; fore part of the body of army worm with Tachina eggs attached below—somewhat enlarged (from Comstock.)

Until comparatively recent times the Tachina flies were generally believed to be among the most effective destroyers of the common army worm and related species, but observations have now shown the fallacy of this belief. On this head Dr. Howard has written[2] that he had searched for hours in grass fields overrun with army worms without finding a single specimen of the "worm" which did not bear upon its back the eggs of *Winthemia 4-pustulata*, but that a very large proportion of these eggs failed to hatch through the molting of the caterpillars attacked. He cites observations made by Professor Fernald and his assistants in their work upon the gypsy moth in Massachusetts. In the case of 235 caterpillars of this moth, which bore from 1 to 33 eggs on each individual, 226 produced moths, and only 4 of the dipterous parasites were obtained from the entire number. The caterpillar which had 33 eggs upon it molted before any of them hatched, and eventually emerged as a moth in good condition.

[1] This Tachinid is the same as described by Dr. Williston under the name *Exorista infesta* in Professor Forbes's report on the fall army worm (25, p. 65), and is also known to attack the common army worm and the larvæ of various cutworms and other injurious Noctuidæ and Bombycidæ. The list included up to 1896 fourteen hosts. This list is given in full in Bulletin No. 7, technical series, of this Division (pp. 21, 22), where also its distribution, characters, and synonymy are discussed.

[2] Tech. Series, No. 5, Div. Ent., p. 51.

The value of ants in interposing checks to the excessive increase of the fall army worm in the South was known in Glover's time, and especial mention is made of them in his report for 1855 (3). Ants are also mentioned by our correspondents as being efficacious in destroying this pest.

Of the operations of ants as destroyers of the "grass-worm" Glover says that on a plantation in the vicinity of Columbus, Ga., numerous colonies had formed their holes or nests in the road passing through the center of an infested field and here lay in wait for any unfortunate caterpillar which should be tempted to cross this dangerous path for a fresh supply of food.

First, one ant more vigilant than the rest would rush to the attack; then another, and another, until the poor caterpillar, entirely covered by its pigmy foes, and completely exhausted in strength by its unavailing efforts to escape, was finally obliged to succumb to superior numbers and die as quietly as possible, when the carcass was immediately carried off by the captors to their nests, or, when too heavy to be dragged away at once, they fed upon it as it lay in the road. This warfare was carried on every day as long as the grass-worms prevailed, and no doubt their numbers were diminished in this way to a considerable extent.

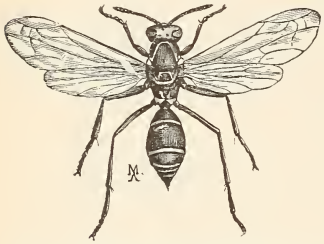

FIG. 6.—*Polistes bellicosus*—somewhat enlarged (Marx del).

Among other material obtained by Dr. Howard during 1881 were three parasites of this species, one of which has been identified by Mr. Coquillett as *Frontina frenchii* Will. The fly issued September 9 from Laphygma larvæ bearing Tachina fly eggs collected at Columbia, S. C.

Apanteles laphygmæ Ashm. MS. was reared August 29 and 30, 1881, from material received from Savannah, Ga.

Mr. Quaintance (40, p. 511) states that there are several species of wasps (*Polistes bellicosus* ? and others) that attack these larvæ, as also a species of Bombyliid, or bee fly, which was reared by him from the larvæ. *Polistes bellicosus* is shown in figure 6.

Limneria dubitata Cr. is mentioned as a doubtful parasite of the fall army worm (Insect Life, Vol. III, p. 158).

The larvæ of a Calosoma, specimens of which were received with a letter dated March 19, 1900, from China Spring, Tex., were observed by Mr. G. G. Hood feeding on the fall army worm. The species is perhaps the fiery ground-beetle (*Calosoma calidum* Fab.), which has been recorded by Professor Morgan to attack this caterpillar (38). The larva of *C. calidum* is shown in figure 7.

Euplectrus comstockii How., a common chalcidid enemy of *Aletia xylina*, or cotton worm, is recorded as a parasite of *Laphygma frugiperda*. From the latter host 25 individuals were reared from a single

larva (4th Report U. S. Ent. Comm., p. 107). This chalcidid is shown in figure 8.

Only one bird other than the English sparrow appears to have been observed attacking this insect. On this head Lyman (6) said: "There appears to be no bird but the blue jay that will eat it."

The foregoing is a short list of known natural enemies of so common an insect. Future observations will doubtless show that there are many others such as we know attack the common army worm, among which are various predaceous ground beetles and mites.

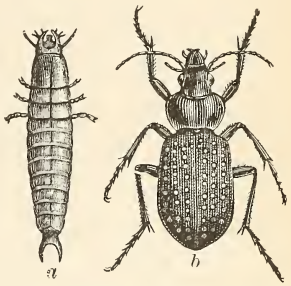

FIG. 7.—*Calosoma calidum*. *a* larva; *b* beetle. Natural size (from Riley).

Years of experience with the common army worm show the great efficiency of natural enemies in keeping down its numbers, serious outbreaks seldom occurring two years in succession.[1] The season of 1899, as previously noted, has shown that we can as yet place very little dependence on insect enemies against the fall army worm.

REMEDIAL MEASURES.

The fall army worm in its manner of life so nearly resembles, in many respects, the common army worm that, when it assumes the habit of traveling in armies, its ravages may be counteracted by a similar line of treatment. The remedies in vogue against the latter were discussed in the Annual Report of this Department for 1879 (pp. 189, 190), and in Circular No. 4, second series, of this Division (pp. 3, 4). As with the common army worm also, unfortunately, injury by this species is seldom detected until too late for the successful application of remedial or preventive measures.

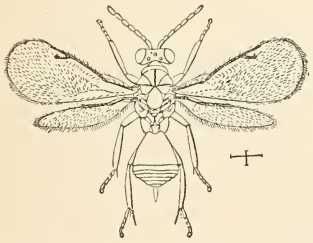

FIG. 8.—*Euplectrus comstockii*, much enlarged (reengraved after Comstock).

THE USE OF INSECTICIDES.

In the case of large armies in extensive fields, plantations, or gardens, poisons are of little value at the time when outbreaks are at their height. When the armies are first noticed the larvæ or "worms" are as a rule approaching maturity, they have effected much damage, and it is difficult at this stage to check them or prevent them from passing from one field, garden, or other tract to another.

[1] A few instances of such recurrence of attack are on record of the present species, *e. g.*, that of the years 1896 and 1897 in Florida.

As a natural sequence it follows that, although poisons are of value in many cases, we must place more reliance in preventives such as are to be found in cultural and mechanical methods.

The arsenicals.—The insects can be destroyed by different poisons, but too often such a course is apt to involve further injury or destruction of the crop infested. Wherever the arsenicals, such as Paris green or London purple, can be used in the form of a spray without injury to the crop as food for cattle or for market, these are indicated.

Certain persons have reported that Paris green and other insecticides employed were effectual in destroying the insects but also killed the plants affected. From experience with infested grasses which were under observation in the vicinity of Washington, we know that it is an easy matter to pass by the insect unrecognized and that the extent of the injury may also be unrecognized at the time when the insect's presence is quite obvious. It is quite probable, therefore, that the cases of reported injury attributed to insecticides were in reality due to the work of the insects themselves.[1]

Kerosene.—Lawns can be freed from the insects, at least in great measure, by the application of kerosene emulsion, followed with as copious a drenching as possible with water from a hose. It is perhaps needless to say that this remedy should not be employed in bright sunlight or on a hot day, but preferably toward sundown.

The value of remedial applications was testified to by some of our correspondents, among whom was Mr. Charles Deering, of Chicago, who wrote, August 25, that kerosene, soap and water, and Paris green, were each effective in killing larvæ near the surface, but when a water sprinkler was turned on, hundreds of active worms came up from the roots of the grass within an area of but a few feet.

MECHANICAL METHODS OF DESTROYING THE "WORMS."

Various mechanical and other measures have proved of value against the common army worm, and would prove effective against the fall army worm. In fields of young grain and on lawns many "worms" or larvæ may be killed by rolling with a heavy roll, preferably when the insects are at work early in the morning or late in the afternoon, toward dusk. In pasture lands and in fields that are injured beyond recovery, sheep or other cattle could be turned in in numbers with benefit, as they will crush the larvæ by trampling upon them.

Other methods of this nature that are in use against the army worm proper, and that will be found of value, include trenching or

[1] In one case in particular there was no doubt whatever that the insects killed a plat of grass, although several of those who noticed the injury claimed that it was due to other causes. Had insecticides been applied these same persons, who, by the way, were not entomologists, would probably have claimed that the insecticides had caused the death of the grass.

ditching, or the plowing of deep furrows in advance of the traveling hosts to entrap the larvæ which will fall into them, and here they may be crushed by dragging logs or pieces of brush through the furrows. If feasible to fill the trenches with water, or if they become partially filled by rains, the addition of a very small quantity of kerosene, so as to form a thin scum over the surface of the water, will prove fatal to the caterpillars.

Sometimes barriers of fence boards are erected, and the tops smeared with tar or other sticky substances, to entrap the larvæ as they attempt to crawl over.

Clean cultural methods and rotation of crops.—Rotation of crops should always be practiced, as well as the burning over of fields in the fall, when they are too badly infested to recover from injury. Above all other precautions which it is necessary to take to secure immunity from attack is that of keeping the fields free from volunteer grain and wild grasses, since experience shows that these are the favorite breeding grounds of the insect; in other words, they attract the female moths for the deposition of their eggs, and when the larvæ hatching from these eggs have devoured the grain and grasses which grow in patches they are driven to cultivated fields for food. A perusal of the preceding pages will convince anyone that one of the most important sources of injury is the rotation of one cereal crop with another, or with grasses, and the planting of crops in fields that have been allowed to run waste to wild grasses and weeds.

As grasses and cereals are the crops most affected by the fall army worm, the soil should always be very thoroughly plowed before planting to any crop, particularly a similar one, and it is inadvisable (not alone on account of the fall army worm but on account of the numerous other common cutworms, wire-worms, and white grubs) to plant wheat, corn, or any other cereal in pasture land unless a crop which is not so subject to infestation by this insect intervenes.

Fall plowing.—From the observed fact that hibernation takes place in the pupal condition in the infested fields, it follows that fall plowing is the most valuable of all preventives of injury, and is therefore always to be practiced where suitable to the crop, soil, and other conditions. In the case of perennial crops fall plowing is not applicable. For alfalfa Mr. Hunter has recommended that the field should be thoroughly "disked," or cultivated with a disk harrow, when practically the same results will be obtained as would follow from plowing of other fields. For lawns a thorough going over with a long-toothed steel rake is the treatment recommended. Treatment of the soil by these methods serves to break up the cells in which the chrysalides are resting, as well as to destroy the insects in other stages in which they may be present in the fields.

Overflowing rice fields; late planting of wheat and rye.—Injury to lowland rice, as pointed out by Dr. Riley, is not apt to be severe, owing to the ability of rice growers to overflow their fields almost at will, while, if necessary, the negro hands employed in these fields can be sent through the fields to brush the "worms" from the plants into the water.

During the outbreak of 1884 in Kansas it was learned that the ravages of this insect could be prevented by postponing the planting of wheat and rye until between September 20 and October 20. This limit for planting, however, will be different in other climates, and will vary slightly with the weather encountered at this time of year.

OTHER MEASURES.

Preventive measures.—While the fall army worm has usually been observed to do its greatest injury in the autumn, the season of 1899 was quite an exception, as many instances of injury were noted in midsummer, and some even as early as June. This is one of the species of which "to be forewarned is to be forearmed;" hence, if careful watch is kept for the earliest appearing generations and remedial and preventive measures are at once employed, the injury which follows from later generations can be very largely diminished. The presence of many forms of cutworms on lawns can be detected by laying down sheets of cloth or boards at night and examining them in the morning, when these larvæ, if present, will be found adhering to the sheets or boards. This method of detection should be tried with the species under discussion.

Poisoned baits.—Where the caterpillars are found to be breeding in the ordinary numbers of cutworms in vegetable gardens, they may be destroyed by the use of poisoned baits and by other methods used in combating cutworms.

A consideration of these baits and other cutworm remedies is given in the concluding paragraphs of this bulletin.

BIBLIOGRAPHICAL LIST.

In the list which follows the writer has endeavored to present mainly references to such publications as have bearing upon the history, habits, and injuries of *Laphygma frugiperda*. Daily newspaper accounts and other publications cited in other lists, and which add nothing of apparent value to a knowledge of the species, are omitted. The list is chronological:

1. Smith, J. E., and Abbot, John.—Natural History of the Lepidopterous Insects of Georgia, Vol. II, pp. 191, 192, Pl. 96. 1797.

Original description as *Phalæna frugiperda*, with brief mention of habit of feeding on Guinea corn, and suggestions as to remedies. Colored plate of larva, pupa, and two forms of moth.

2. Guenee, Achille.—Noctuélites, Vol. I, p. 159, Paris. 1852.

Description of larva and imago and distribution.

3. Glover, Townend.—Report of Commissioner of Patents for 1855 (1856), pp. 77–79, Pl. VI, fig. 6.

General article under the heading "The grass caterpillar." Account of injuries to crops in Georgia in 1854, description of larva, pupa, and moth, with note of injurious occurrence in 1845. Original figure of larva, pupa, and moth.

4. Landon, M. D.—Report of Commissioner of Agriculture for 1864 (1865), pp. 89, 90.

A short account under the name of "grass caterpillar," in connection with injury to cotton.

5. Glover, Townend.—Monthly Report U. S. Depart. Agriculture, October, 1866, pp. 377, 378, figure.

A two-page general account, consisting in large part of a repetition of No. 3. Specific mention as *Laphygma machra*, with observation that it may prove to be *L. frugiperda* S. and A.

6. Lyman, Joseph B.—Cotton Culture, pp. 92–94, fig. 17. New York, 1868.

A three-page popular account under the heading "The army worm." The larva and moth figured are *Laphygma frugiperda*.

7. Riley, C. V.—First Report on Insects of Missouri, pp. 87, 88. 1868.

Mention under the heading "The wheat cutworm" of injury in 1868 at Allenton, Mo., and elsewhere to wheat, oats, grasses, etc., with description of the larva.

8. Walsh, B. D., and Riley, C. V.—American Entomologist, v. II, p. 43. November, 1869.

Reference to this insect in connection with a consideration of the boll worm and suggestion that it be called "Daggy's cornworm, *Prodenia Daggyi*."

9. Riley, C. V.—American Entomologist, v. II, p. 239. November, 1870.

General account with original illustration of the larva.

10. Riley, C. V.—American Entomologist, v. II, pp. 363–365. December, 1870.

A longer general account than the preceding of which it is in continuation, with original figures of the moth and description as *Prodenia autumnalis* n. sp.; also description of larva and pupa.

11. Riley, C. V.—Second Report on Insects of Missouri, p. 41. 1870.

Brief reference to this insect as "*Laphrygma frugiperda* Sm. and Abb.?" in connection with its resemblance to the army worm.

12. Riley, C. V.—American Entomologist, v. II, p. 340. October, 1870.

Answers to correspondents complaining of injuries at Ottawa, Kans., and Eureka, Mo.

13. Riley, C. V.—Third Report of Insects of Missouri, pp. 109–117. 1871.

A general consideration of the species with reports of injuries in 1870 in Missouri and Kansas, with technical description of the moth, larva, and pupa.

14. Glover, Townend.—Report of Commissioner of Agriculture for 1872, p. 118. 1874.

"In some localities [in Georgia] the grass caterpillar or grass army worm (*Prodenia autumnalis*) devoured the corn, grass, and pea crops in 1872."

15. Riley, C. V.—Eighth Report on Insects of Missouri, pp. 48, 49. 1876.

Brief consideration in connection with a longer account of the army worm proper. Species identified as the *Phalæna frugiperda* S. and A.

16. Thomas, Cyrus.—Seventh Report State Entomologist of Illinois, 1878, p. 97.

A short account and reference to injuries in Washington County, Ill., in about 1873.

17. French, G. H.—Seventh Report State Entomologist of Illinois, 1878, p. 219.

Brief general account.

18. Glover, Townend.—Manuscript notes from my Journal, Cotton, and the principal insects, etc., frequenting or injuring the plant in the United States, 1878. Pl. IX, figs. 9–12.

Copper plate illustrations of moths, larvæ, pupa, and cocoon, with brief notes on the insect's habits.

19. Comstock, J. H.—Report upon Cotton Insects, p. 180. 1879.

Quotes Glover as regards carnivorous habit of the larva.

20. Riley, C. V.—American Naturalist, v. XV, p. 751. 1881.

Brief mention of injury to rice in Georgia.

21. Thomas, Cyrus.—Tenth Report State Entomologist of Illinois, p. 138. 1881.

A brief description of the larva.

22. Riley, C. V.—Papilio, v. II, p. 43. March, 1882.

Note on nomenclature.

23. Riley, C. V.—Third Report of U. S. Entomological Commission, 1880–82, pp. 89–98. 1883.

Damage in 1874 to grass in Richmond County, S. C., Heard County, Ga., and Macon County, Ala., and attributed by Glover to *Leucania unipuncta* deemed likely to have been due to *Laphygma frugiperda* and not Leucania.

24. Riley, C. V.—Report of Commissioner of Agriculture for 1882, p. 138. 1883.

Short note on injuries observed in 1881 to rice fields and to other crops in the South with mention of the value of flooding as a remedy in lowland rice fields.

25. Forbes, S. A.—Circular, Office of State Entomologist, October 14, 1884. <Prairie Farmer, October 25, 1884. <Farmers' Review, October 30, 1884. (Not seen by the writer.)

26. Snow, F. H.—Fourth Bien. Rept. Kans. State Board of Agriculture for 1883–84, pp. 609–611. 1885.

Accounts of injuries in four counties in Kansas in 1884.

27. Forbes, S. A.—Fourteenth Report State Entomologist Illinois, 1884, pp. 55–67. 1885.

Full general account including consideration of injuries in 1884, literature, nomenclature, description of larva and imago, distribution, life history, character and extent of injuries, natural enemies and prevention and remedy.

28. Hubbard, H. G.—Insects affecting the Orange, pp. 150, 151. 1885.

Short general account with reference to the occurrence of the eggs and the feeding of the young caterpillars on orange leaves.

29. Riley, C. V.—Fourth Report U. S. Entomological Commission, p. 353, pl. LXII, fig. 2. 1885.

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30. Webster, F. M.—Thirty-fifth Ann. Rept. Indiana State Board of Agriculture, 1885, v. 38, p. 197. 1886. (Author's Extra, p. 18. 1885.)

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31. Lintner, J. A.—Bul. New York State Museum of Natural History, No. 6, pp. 11, 14, 16, 20, figs. 18, 23. November, 1888.

Brief treatment in connection with injury by cutworms.

32. Webster, F. M.—Bul. 22 Div. Entom., U. S. Dept. Agriculture, pp. 46, 47. 1890.

A six-line note on occurrence in 1885 and 1889 on corn at Lafayette, Ind.

33. [Riley and Howard.]—Insect Life, Vol. III, p. 158. November, 1890.

Records the rearing of *Limneria dubitata* Cr. from *L. frugiperda* (?), Indiana, October 9, 1884.

34. Weed, H. E.—Southern Live-Stock Journal, October 15, 1891. (Not seen by writer.)

35. Kellogg, V. L.—Common Injurious Insects of Kansas, University of Kansas, 1892, pp. 39, 40.

Popular economic account, reference to injury at Mineral Point, Kansas, in 1866 and 1870.

36. Bruner, L.—Ann. Rept. Nebraska State Board Agriculture, 1891, pp. 249–252, 1892. <Do. for 1893, pp. 386–390.

A general economic account, including free quotations from Forbes.

37. Coquillett, D. W.—Insect Life, Vol. V, p. 312. July, 1893.

Mere mention of occurrence at light on flowers of *Yucca whipplei*.

38. Morgan, H. A.—Bul. 22, Louisiana Experiment Station, pp. 734, 735. 1893.

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39. Smith, J. B.—Bul. 44, U. S. National Museum, p. 168. 1893.

Systematic bibliography and synonomy.

40. Mally, F. W.—Bul. 29, Div. Ent., U. S. Dept. Agr., p. 30. 1893.

Abundant upon trap corn in June and July; mistaken for boll worm by planters.

41. Weed, H. E.—Bul. 36, Mississippi Agricultural Experiment Station, pp. 152, 153. November, 1895.

A short general economic account.

42. Smith, J. B.—Economic Entomology. pp. 297, 298. 1896.

Popular economic account.

43. Howard, L. O.—Bul. 33, Office of Expt. Stations, U. S. Dept. Agriculture, p. 346. 1896.<Farmers' Bulletin No. 47. 1897.

Reference to the occurrence of this insect in cotton fields.

44. Quaintance, A. L.—Bul. 40, Florida agricultural experiment station, pp. 507–512. July, 1897.

A general and economic account and report of destruction of grasses in 1896 and 1897 in Florida.

45. Coquillett, D. W.—Technical Series, No. 7, Division of Entomology, U. S. Dept. Agriculture, p. 25. 1897.

Records rearing of *Gonia capitata* DeG. and *Winthemia 4-pustulata* Fab. from this host.

46. Lugger, Otto.—Bul. 61, Div. Entomology, Agl. Exp. Sta. Univ. Minnesota, p. 218. December, 1898. (Fourth Ann. Rept. Do., p. 164. 1899.)

Short popular account.

47. Hunter, W. D.—Press Bul. Circular No. 2, Agric. Expt. Station Univ. of Nebraska, pp. 4, fig. 1. September 23, 1899.

A general economic account, with reports of injuries in Nebraska in 1899. Original illustration.

48. Webster, F. M.—Ohio Farmer, November 2, 1899, p. 340.

Answer to correspondent complaining of injury at Haverhill, Ohio.

49. Adams, M. F.—Ann. Rept. Buff. For. Assoc., p. 11. April 1, 1900.

Destruction of turf on lawns at Buffalo, N.Y. A few notes on the insect's habits.

50. Chittenden, F. H.—Bul. 23, new series, Division of Entomology, U. S. Dept. of Agriculture, pp. 78–85, fig. 19. 1900.

A general seven-page account preliminary to the paper here presented, and with particular reference to reported injuries in 1899. One original figure.

51. Webster, F. M.—Bul. 26, Division of Entomology, U. S. Dept. of Agriculture, p. 85. October, 1900.

Brief reference to injury in southern Ohio in fall of 1899.

52. Forbes, S. A., and Hart, C. A.—Bul. 60, Univ. Ill. Agric. Exp. Sta., Urbana, pp. 497, 498. August, 1900.

A short general notice, with especial reference to the occurrence of the species in localities which are mentioned, in Illinois, during 1899, with brief note on probable hibernation as pupa.

53. Bruner, Lawrence.—Thirteenth Annual Rept. U. S. Agl. Expt. Sta. Nebr., pp. 47, 48. 1900.

Brief notice of injuries in Nebraska in 1899, with localities and crops affected.

54. Chittenden, F. H.—Bul. 27, new series, Div. Entomology, U. S. Dept. of Agriculture, pp. 73, 74. May, 1901.

A short notice of this species, with particular reference to its injuries to the violet.

55. Pettit, R. H.—Bul. 186, Mich. State Agric. College Exp. Sta., December, 1900, p. 30. 1901.

Notice of injury to corn at Chatham, Mich.

56. Gillette, C. P.—Beet Sugar Gazette, July, 1900, Rept. No. 69, U. S. Dept. of Agriculture, pp. 86, 87. 1901.

Deals chiefly with remedies.

THE VARIEGATED CUTWORM.

(*Peridroma saucia* Huebn.)

This cutworm is usually to be found in some numbers nearly everywhere—in gardens, pasture land, vineyards, fields, and orchards, and even in greenhouses, as it is a general feeder and able to eke out a living wherever it may happen to be.

Even in ordinary seasons it appears to have little choice as regards the quality of its food—anything succulent, whether the leaves, buds, flowers, fruit, stalks, tubers, or roots of plants of the garden, field, or greenhouse, serving the larvæ as a means of sustenance. It does not appear to be especially fond of wild plants, and is not, like the fall army worm, an important enemy of grasses or grains, although it feeds sometimes upon both when other foods are not available. It is seldom noticed attacking weeds, appearing to prefer cultivated plants to others. It is one of the so-called climbing cutworms, often doing much injury to the foliage of fruit trees, and in seasons of exceptional abundance it assumes the army-worm habit.

There is little doubt, from reports that were received, that this habit was assumed in many localities where injuries were noticed. In fact, the variegated cutworm was so abundant during the season that it became quite generally known as the army worm in some regions, as, for example, in the Pacific States and British Columbia, where it was most destructive.

Injury, judging from report, extended from Maryland southward to Texas and westward to the Pacific coast. It was most pronounced in Oregon, Washington, and northern California, and was noted in various portions of Canada. The species was probably present in some numbers throughout practically the entire United States and Canada wherever truck crops were raised, although injury, as nearly always happens in the case of insect attack, was more or less local. The insect did not by any means confine itself to garden vegetables, however, but was very destructive to ornamental flowers, and the list of plants attacked included nearly everything that could be mentioned, only a few plants being noticed as exempt from injury.

The occurrence of this species in Canada was described by Dr. Fletcher as one of the most remarkable outbreaks of an injurious insect that had ever been recorded in that country, and this was about equally true in the States of Oregon and Washington. It is seldom

that a year passes that this cutworm is not reported as the cause of more or less loss to the farmer, wheat grower, and florist, but the season of 1900 was by far the most remarkable in its history.

DESCRIPTION.

The moth.—The progenitor of this cutworm is a large, somewhat inconspicuous moth, the species belonging, as do other cutworms, to the family Noctuidæ. The fore-wings are pale grayish-brown, tinged with reddish and shaded about the middle and toward the outer margin with darker brown. There is considerable variability in the depth of color and in the markings, the latter being often suffused. A common form of the moth is shown (fig. 9, *a*). The reniform spot is some-

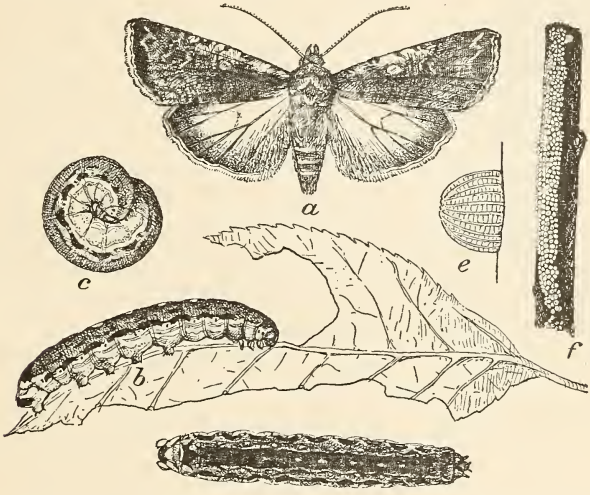

FIG. 9.—*Peridroma saucia: a*, moth; *b*, normal form of larva, lateral view; *c*, same in curved position; *d*, dark form, dorsal view; *e*, egg from side; *f*, egg mass on twig (after Howard).

times pronounced, as is also a rounded spot near the reniform and between it and the base of the wing.

The ground color of the hind-wings is iridescent or pearly white, strongly shaded about the margins with shining light brown, the veins being of a similar color and strongly marked. The head and thorax are of about the same general color as the fore-wings, while the abdomen is a little lighter and thickly covered with long paler pubescence which extends nearly to the middle. The wing expanse is about an inch and three-fourths (44 mm.), and the length of the body is about three-fourths of an inch (19 mm.).

The egg.—The egg is of the usual semiglobular form seen in the cutworm group of Noctuids. The outline is circular, the surface is strongly ribbed, the ribs, about 42 in number, radiating from the center and extending in points beyond the sides. These ribs are

crossed by others which encircle the egg. The eggs are laid in regular masses and often in rows of about seven or eight, and to the number of sixty or thereabouts, and frequently along the twigs of fruit trees. An egg is shown in profile very much enlarged at *e* of figure 9, and from above in the lower portion of figure 10. The upper portion of the latter figure shows an egg mass of this moth as deposited upon a leaf of cowpea, while at *f* of figure 9 another mass is shown deposited upon a twig.

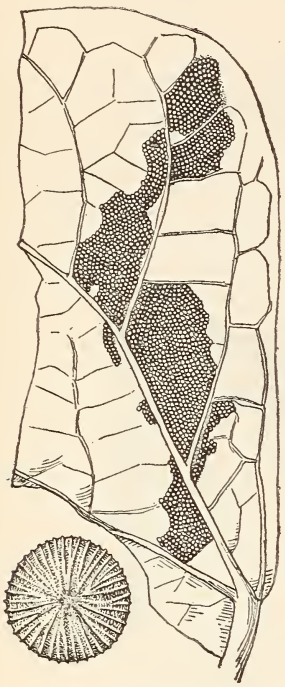

Fig. 10.—*Peridroma saucia:* Egg mass on cowpea leaf; egg much enlarged at left below (original).

The larva.—The larvæ when first hatched are green in color, with indistinct lines, and a very few scattered hairs, the head being black. They undergo several molts before reaching full maturity, but as all these different stages (five in number) have been described elsewhere they will be omitted. Rather complete descriptions are given in the late Dr. J. A. Lintner's fifth report on the insects of New York.[1]

At maturity the larva has attained a considerable size, measuring about one and three-fourths inches (45 mm.) in length and one-fourth inch (6 mm.) in width. At this stage the larva is even more variable than the moth, that shown in the illustration at *d* (fig. 9) being of the darkest form, drawn from a lot found injuring fruit trees. When the larva feeds on low-growing plants, such as celery, the color appears to be usually very much lighter, particularly in individuals that have passed the winter in the ground. An extreme pale form is shown at figure 11. The general color of the dark form is rather dull brown, often with a greenish tinge (which becomes purplish by inflation), finely mottled with gray and smoky black above. The ventral surface is much paler dull-gray, often with a carneous tint. The velvety, black, undulating, interrupted stripes with which the sides are ornamented, as also the row of short, longitudinal, black lines on each segment and the row of from four to six yellow, mediodorsal, rounded spots, which are more or less prominent on the second to the fifth to seventh segments, are all sufficiently shown at *b* and *d* (fig. 9). The

Fig. 11.—*Peridroma saucia:* pale form of larva—enlarged about one-fourth (original).

[1] A good general account, with bibliography up to that date (1889), will also be found on pages 200–206 of the same publication.

head is reddish-yellow in life, becoming pale-brown in preserved specimens, and is reticulated with red and black. A broad, incurved band of black runs from top to bottom each side of the inverted V spaces, forming a somewhat imperfect letter H. The antepenultimate segment is marked above with black velvet spots, and the anal segment is marked with a light, often reddish, nearly semicircular spot.

In the paler forms the markings are much fainter, with the exception of the red of the last segment.

The pupa.—The pupa does not present any characteristics particularly different from those of other cutworms. It is of the usual shining yellowish color when first formed, changing to dark mahogany brown toward maturity. The tip ends in a pair of minute spines.[1]

DISTRIBUTION.

Peridroma saucia is cosmopolitan; it perhaps originated in Asia Minor or southern Europe and is doubtless a direct and early importation from our parent country, since it has been recognized here for many years, as early at least as 1841, when it received mention by Harris. The recorded distribution abroad includes Great Britain and Ireland, western-central and southern Europe, Asia Minor, North Africa, Madeira, and Teneriffe. On this side of the Atlantic it is known from Canada and New England westward to California and British Columbia in the north, and southward through the Gulf region to Mexico, Guatemala, Costa Rica, and Panama in Central America, and Colombia, Venezuela, Brazil, Argentina, Chile, and Patagonia in South America.

It is injurious practically throughout the arable region of the United States.

REPORTS OF INJURY.

REPORTS OF CORRESPONDENTS IN 1900.

As this cutworm showed itself to be one of the most troublesome insects of the year 1900, and as no authentic list of food plants has ever been made out in shape for convenient reference, it has been deemed advisable to cite such occurrences as have come under observation during the past season somewhat in detail. The reports which will be cited were accompanied (in all except, perhaps, one instance), up to the middle of August, by specimens of larvæ, mostly approaching maturity.

May 12, 1900, Mr. G. A. Schattenberg, Boerne, Tex., wrote that this cutworm was doing damage in sweet pea, pansy, and asparagus beds in that vicinity. On the 23d of May Mr. H. J. Gerling, St. Charles, Mo., sent larvæ attacking rhubarb and radish, the two plants

[1] Dr. Lintner (l. c., p. 204) in describing the pupa, states that the anal tip is armed with a single short, black, curved spine.

about equally relished. May 25 this larva was found by the writer at work on young beets on the Department grounds. May 28 Mr. W. C. Hollowell, Barnes, Kans., wrote that this cutworm was devouring the corn in that county, and that there were hundreds of acres that were cut off. The larvæ began attack upon the blades, eating down the heart for 2 or 3 inches under the ground. This cutworm was described as devouring everything, including weeds of various kinds. One patch of potatoes had been completely stripped of leaves. The same day Mr. Warren Knaus, McPherson, Kans., sent larvæ with the report that they were doing considerable damage in McPherson and adjoining counties, eating all kinds of garden vegetables, and being especially destructive to alfalfa.

During June this species was sent to us on the 1st by Mr. W. H. Edwards, Coalburg, W. Va., as being concerned in injury to cabbage and tomato in that locality. The same day Mr. E. M. Wright, Eureka, Ill., sent this cutworm found on cabbage. June 5 Mr. Knaus, who is an entomologist of experience and reputation, reported that many individuals were found beneath pea vines and in a lettuce bed. He stated that this species attacks all garden vegetation except growing beans, and defoliates currant and gooseberry bushes and box elder trees. Potato vines were attacked, particularly in the vicinity of fields of alfalfa, which seems to be the principal host plant in that vicinity. Sunflower, hollyhock, and cocklebur were also attacked.

In July Mrs. Dora Hans, Quilcene, Jefferson County, Wash., wrote on the 17th that it was eating everything in the shape of garden flowers, and even grasses. The larvæ were described as cleaning everything to the ground, and at the time of writing were defoliating fruit trees. Tomatoes, onions, lettuce, potatoes, and other garden truck were also injured. On the 20th Mr. Ernst Stock, Chicago, Ill., reported that it was known as the army worm in that vicinity and had destroyed his lawn entirely the previous year.[1] It appeared to eat the roots of the grass so that the grass soon died. On the 21st Mr. A. J. Maise, Dora, Coos County, Oreg., made a report that this species was doing a great deal of damage in that section, destroying garden and other vegetation. July 23 Mr. Thomas Oswald, Wynooche, Chehalis County, Wash., wrote that this cutworm was a pest in that country, eating everything in the gardens. The insect had damaged hay fields very badly; it was observed also on cabbage. Some of the residents called it the army worm, but the caterpillars were not noticed traveling, although very abundant in some places. July 26 Miss Daisy Fowler, Burley, Wash., wrote that this insect was eating flowers and vegetables in that vicinity. Only the poppy seemed exempt

[1]The injury in 1899 was doubtless due to the fall army worm, as that species was very troublesome on Chicago lawns that year, as has already been stated.

from attack. The same day Rev. M. Eells, Union, Mason County, Wash., stated that this species, locally known as the "army worm," had, within two weeks, appeared there in great numbers and "seemed to be taking everything." Its appearance was noticed for the first time in the history of that region. Next day Mr. S. M. Pressey, Deer Harbor, San Juan County, Wash., sent larvæ with the report that they were very numerous and were eating and destroying everything green on his and neighboring farms. The larvæ devoured all kinds of fruit on the trees, also the leaves, and in some cases attacked the bark. They crawled into houses and wells, and "almost everywhere." Orchards were overrun with them as by a plague. July 28 Mr. E. E. Hogbery wrote that this species was playing havoc with potatoes and garden stuff in his section, Fishhawk, Oreg. The cutworms were described as being so thick on the ground in some places that our correspondent killed them under foot with every step he took. He believed that they would eventually attack everything green, and their presence was alarming the community greatly.

August 6 we received word from Mr. R. A. Easton, Dora, Oreg., that this insect was doing serious damage to crops in Coos County. Potatoes, tops and tubers, were eaten, as also other vegetables and clover. The same day we received from Mr. Richard C. Willis, Olga, San Juan County, Wash., a communication in regard to this insect. It had appeared there in great numbers and was eating up almost everything in the truck line. A locality known as East Sound was also invaded. August 9 Mr. Maise wrote that in that vicinity the damage was greatest in pastures and to potatoes, beets, and cabbage. In some localities the cutworms were troublesome on fruit trees, eating the fruit and cutting the bark around grafts. They were noticed traveling at night, and early in the morning dropped down on the ground and hid themselves away from view.

In a letter dated August 14, with accompanying specimens mostly in the pupal condition, Mr. Willis reported that the larvæ were eating all kinds of garden stuff—potatoes, tomatoes, beans, peas, beets, carrots, corn, cabbage, turnips, rutabagas, and onions, leaving only parsnip and squash. At the time of this writing they were busy upon field peas, potatoes, and clover, and were damaging prune, apple, and other fruit trees in spite of applications of tarred paper and bands of wool and cotton batting. They worked only at night, and when feeding could be heard at some little distance. On the 22d we received from Mr. J. A. McDonald a communication dated July 29 complaining of this species at Requa, Cal. The insect was stated to have made its first appearance that summer in that part of the country. The caterpillars fed on nearly everything, including fruit trees, of which they devoured both foliage and fruit. After eating potato vines they devoured the potatoes. In fields infested by them the ground was

covered with their numbers. August 24 we received another communication from Mr. Willis, containing very complete notes on the plants affected on Orcas Island, San Juan County, Wash. In the case of attack on beets the stems were sometimes bored out and cut off at the surface of the ground, the leaves being eaten in some cases. The leaves of young cabbage were devoured, while of older cabbages the heart was usually attacked. Of turnips the green portions of the leaves were devoured, leaving only the stalks, the roots being eaten to a shell. The leaves and upper portion of the roots of carrots were devoured, and beans were injured by the cutworms boring into the pods, sometimes eating the beans within. Peas were similarly affected, young plants just before flowering being "eaten clean." The tops of onions were eaten off level with the ground, leaving only the roots. Of tomatoes the leaves and fruit were eaten, as were also the leaves of corn and the inside husks on the cobs. Entire lettuce plants were eaten. Only the leaves of potatoes were usually attacked, leaving the stalks, but the tubers were often eaten into and sometimes riddled with holes. The foliage of apple, pear, and plum was attacked and windfalls of fruit were eaten to the core; ripe fruit was greatly preferred to green. Squash and vegetable marrow were untouched. The same day Mr. Thomas Oswald sent pupæ from Wynooche, Wash., with information that the "old settlers" of that neighborhood were authority for the statement that this cutworm was present in that county thirty or thirty-five years previously, had been injurious for one year, and had not returned until 1900.

Writing September 1, Mr. Willis stated that toward the end of the month of August the cutworms had practically disappeared, only four being found on the day of writing. In a field that had been fall-plowed and left in fallow and had become grown up with weeds this cutworm was found to eat plantain, clover, and fireweed, the latter appearing to be the favorite food. Injury was complicated in the case of attack to onions, an unknown green caterpillar being associated with the cutworm. The latter severed the onion stalks above the ground, and individuals of the other species appeared to go down inside of a leaf and eat about the root.

As an instance of the numbers of this species, Mr. R. A. Easton, Dora, Oreg., writing September 18, 1900, stated that he had been informed that 202 of these cutworms had been dug up from a piece of ground only 1 by 2 feet in size.

September 20, Mr. Carroll Fowler, Berkeley, Cal., sent specimens of reared moths with the information that they were received from Mendocino County, and that the species also occurred in Humboldt County, in California. In the former county the caterpillars were stated to have destroyed several acres of onions, and afterwards 60 acres of garden peas. The moths emerged September 18.

NEWSPAPER NOTICES OF INJURIOUS WESTERN OCCURRENCES.

Through the kindness of Mr. V. K. Chesnut, the writer received some clippings from a Seattle (Washington) daily journal. One dated July 25, 1900, contained a column notice of this insect, identified as *Peridroma saucia*, with quotations from different persons who had suffered from its ravages. From these accounts it appears that the insect was first noticed in Seattle during the first week of July. One person reported that he had gathered two hundred "worms" from about the roots of a single cabbage plant, the stem of which was completely honeycombed. A like number was collected from under a shingle overnight.

Another newspaper from the same city published an account stating that the entire productive area of King County, in which Seattle is located, was being devastated. In this account it is stated that this cutworm "is migratory and travels across country as does the army worm of the East." General complaint was being made from all directions. In the city of Seattle this cutworm was destroying lawns, flower and kitchen gardens, and truck of all kinds; in the suburbs it was everywhere and destroying everything. In the country its ravages were general. "One day a field would appear perfectly free from it, and the next the worm would be swarming over everything. * * * It burrows in the earth and attacks the tubers of potato, destroying them as ruthlessly as it does the foliage. One potato was shown that had buried under its skin a half dozen big repulsive worms. The pest is no less a thing than a plague, and from the way it is starting out it will occasion untold damage to all kinds of crops."

It was stated in this account, among other things, that "it looks as if the farmers will have as serious a time with this new pest as they have ever had with the hop louse; certainly its appearance has created more general alarm than any pest that has ever made its appearance in the past."

The California Fruit Grower of August 11, 1900, had some notes on the occurrence of this species, which was stated to have appeared in different places in Washington and Oregon a little after the middle of July. The damage was greatest to garden vegetables, including late potatoes, but root crops, wheat, hops, and fruit trees were also damaged. The cutworm was described as being so ravenous that it ate clover at the roots. Tar applied at the base of the poles in hop fields protected hops. In the first ten or twelve days after the appearance of the pest about half of the entire vegetable crop was destroyed in some sections. At Fern Hill, Wash., the cutworms were eating fruit and leaves of pear trees; at Melbourne they were "cleaning up everything," half a dozen of the pests being present on every square foot of ground; at Kalama the cutworms were "doing great damage to all growing crops, climbing trees and nipping the fruit, eating potatoes in the ground as well as the tops."

Notice is given of a disastrous outbreak of this cutworm all through the Province of British Columbia during the season of 1900, by Dr. James Fletcher in his article entitled Injurious Insects in Ontario for 1900 (Thirty-first Annual Report Ent. Soc. Ontario for 1900 [1901], pp. 68, 69). Some notes are also given on this species in connection with its occurrence at Ottawa, Canada, it being stated, among other things, that it attacked garden plants and apple trees.

A still more elaborate report upon the outbreak of this species in the various provinces of Canada was given by the same writer in his report as entomologist and botanist of the Experimental Farms of the Dominion of Canada for 1900, pages 215–227. This includes detailed accounts of injuries similar to those that have been reported in the present bulletin in different localities in British Columbia, where injury was most severe, with briefer mention of the occurrence of the species in Manitoba and Ontario, where it was stated to have been more than usually abundant. The first intimation of the outbreak was received from Kelowna, British Columbia, in a letter dated July 9, and every day after this for more than a month letters were received by Dr. Fletcher, accompanied by specimens, as in the case of injuries reported to this office, all of which proved to be the species under discussion.

Injuries in Canada, as previously stated, were chiefly in British Columbia, and may be briefly summed up: At Kelowna, British Columbia, the tobacco crop was quite seriously injured. At Victoria and Lulu Island, Cowitchan, Chilliwack, and Saanich injury was also reported; "whole fields of carrots and other things were cleared off." In consequence of the exhaustion of Paris green in the Province and adjoining States the Canadian Government was telegraphed for 500 pounds of this insecticide. This was as early as July 30. The lawns about the government buildings at Victoria were swarming with these cutworms, and they were rolled, this having the effect of killing them by thousands. At Salt Spring Island it was noticed that some of the cutworms devoured those which had been poisoned. At Dog Creek potatoes were quite severely injured, and when the cutworms had finished eating the leaves of potatoes they began to cross a fence into a garden. A ditch was cut and water turned in, which had the effect of drowning them by thousands. This is sufficient evidence that the species had assumed the army-worm habit in that vicinity. Oviposition was noticed on the leaves of hops August 10. Injury in the locality mentioned was also noticed to peas and beans. The cutworms ate the ends of the pods and afterwards the contents. Of onions they ate the tops and then went down the stalks. Injury was mentioned at a locality designated as the 150-mile House; also at Horse Fly, Soda Creek, Quesnelle Mouth, and New Westminster.

Gardens generally were being destroyed in some of these localities, and nasturtiums were attacked. At Comox the cutworms were described as having attacked everything green, field and garden crops and house plants. Somewhat similar reports of injuries were received from Agassiz and Froek, and at Saanich grain crops were suffering. At Agassiz it was noticed that a species of cedar (*Thuja vervæncana*) was being eaten. Many of the cutworms were entering the ground at this last-mentioned locality July 27, preparatory to forming chrysalides. Mr. J. W. Webb, Maywood, Victoria, British Columbia, reported, under date of July 28, that whole crops were being entirely eaten, and that around five turnips in his garden he found 236 cutworms. Every flower bud of carnations was eaten, and dahlias were devoured to the stems. The insects had entered conservatories and tomato houses. Later injury was reported at Langley Prairie, Caslo, and Armstrong. In the last-mentioned locality the species was known as the army worm. At Nanaimo this cutworm was reported, August 13, as having traveled when food was scarce and having stripped nettles and thistles, and done injury to clover, as well as to mangels, potatoes, and turnips. Into these root crops they had bored whenever near the surface of the ground. At Okanagan Mission a copious irrigation proved a good method of controlling this cutworm.

An epitome of the occurrence of this species in the vicinity of Victoria, based chiefly upon the observations of Mr. J. R. Anderson, concludes Dr. Fletcher's account of injuries, in which the fact is brought out that attack was probable in Idaho. The potato crop was probably reduced one-third, and other root crops in proportion. The second crop of clover was almost entirely destroyed. From other accounts it seems that peas were severely attacked. In one instance the crop was lessened 50 per cent. Altogether the period of attack lasted from six weeks to two months. Caterpillars captured by Mr. Anderson were all in chrysalis by the end of August or the beginning of September, and a number of moths emerged in October.

INJURY DURING 1901.

During July, 1901, Mr. A. Lloyd Rockwell, Monroeton, Pa., sent on the 5th larvæ, with report that the species was attacking tobacco, moving about on the plant in the same manner as the common green tobacco worms. On the 6th Mr. J. F. Littooy, Everett, Wash., sent specimens of this cutworm, reporting its reappearance in that vicinity about the 1st of July. This was the date of the first active appearance, although larvæ had been noticed the 1st of April. It was also noted on cabbage from California. July 26 egg masses of this species were received from Mr. W. S. Stockbridge, Glencarlyn, Va., on apple twigs. At Tioga, Pa., according to Mr. C. L. Miller, who wrote on the 31st, these cutworms were proving a pest on tobacco and cucumbers.

INJURY IN GREENHOUSES.

The following reports of injury in greenhouses have reached this Division in the last few years, each communication having been accompanied by specimens:

December 19, 1894, word was received from the Florists' Exchange, New York City, that this species was very destructive to rose and carnation plants in greenhouses near that city.

April 29, 1895, through the American Florist, Chicago, Ill., a report was received that the cutworm was very destructive in greenhouses.

In 1898, Mr. John Spaulding, New London, Conn., writing April 12, stated that this cutworm bored into the calyx of carnation flowers and cut up the petals, and, but for the vigilance of his employees in hunting it nightly, it would have destroyed a bed 40 by 6 feet. October 26, moths were received from Mr. B. E. Scruggs, Campbell, Va. This cutworm was found on cultivated violets at that place. November 25 of the same year larvæ were received from Mrs. F. B. Boone, Charlottesville, Va., with the statement that they were found in violet houses and ate the blossoms.

MISCELLANEOUS OBSERVATIONS.

In addition to the larvæ which have been mentioned as having been observed in the neighborhood of the District of Columbia and as having been received from correspondents, others were taken at intervals in and near the city of Washington during 1900—August 16 on squash and September 17 on plantain (*Plantago lanceolata*). Pupation of individuals received from the Pacific States began early in August, and by the middle of the month many had transformed. The first moth obtained issued August 25 from material received from Olga, Wash. From moths in confinement eggs were obtained August 27, which began hatching at 3 p. m. of September 6, the duration of the egg stage in this instance having been about ten days. From this lot larvæ matured October 3, or in twenty-seven days. Hence we may say that the larval stage in the warm weather of fall which prevails in the District of Columbia is about four weeks. When in ordinarily fine earth the larva constructs a quite firm cocoon, at least in the autumn. Possibly earlier in the season a less substantial one is made.

BIOLOGIC LITERATURE.

As this is one of the most destructive as well as best known cutworms of North America its economic literature is considerable. In European writings it is seldom noticed as injurious.

It was given its specific name by Huebner in 1816 (Samml. Eur. Schmett. Noct., p. 378), but is credited with having been first described and figured by Ernst & Engrammelle as *La Rubiconde* in 1790 (Papillons d'Europe, Vol. VII, p. 65, pl. 278, fig. 455). It appears to have been first recognized in this country, as previously noted, in 1841, by

Harris, who described it as new under the impression that it was native, giving it the name of *Agrotis inermis* or unarmed rustic moth (Rept. Ins. Mass. Inj. to Veg., 1841, p. 323).

This was the first of the twelve species of cutworms treated by the late Dr. Riley in his first Report on Insects of Missouri (1868, p. 72). It was reported as doing considerable damage to grapevines grown in cold frames. Mention was made of the finding of egg masses of this insect on twigs of apple and mulberry trees, the account concluding with descriptions of all stages, which were also figured.

In Departmental publications this species has received brief notice in the Annual Report for 1884 (pp. 298, 299), and in Insect Life it is mentioned in connection with injuries to carnations (Vols. II, p. 376, and IV, p. 405). In the case of injury last cited, 400 or 500 buds were destroyed in one greenhouse in less than a month. In the same publication serious depredations to potato, cabbage, and tomato plants in Arkansas are noted (Vol. III, p. 149).

In later years various accounts were given, one of the best by Dr. Lintner, who furnished a bibliography up to 1888, his account appearing the year following (Fifth Report Ins. N. Y., pp. 200–206).

A good account, with original figures, was given by Mr. M. V. Slingerland in 1895 (Bul. 104, Cornell Univ. Agl. Expt. Sta., pp. 579–584).

This species was considered in a paper entitled "Insects infesting carnations," and published by F. A. Sirrine in the American Florist for March 3, 1900, page 912. He stated that this cutworm, with the cabbage looper, was the worst of the transient pests in greenhouses where carnations were grown. Indications were that this cutworm enters forcing houses not by being introduced in the soil but through eggs deposited by the parent moth in the houses after transplanting.

An earlier account of injury by this cutworm to carnations was given by Dr. E. P. Felt (Country Gentleman, May 11, 1899). He stated that the leaves were not only considerably eaten, but the buds had also been excavated, and in one or two cases the cutworm was found nearly hidden in the almost empty calyx.

Since the present bulletin was prepared for publication Messrs. R. W. Doane and D. A. Brodie have issued a 16-page publication upon this insect as Bulletin 47 of the Washington State experiment station. The account in question has particular reference to the invasion of 1900, and includes, besides, a brief history of this species and its introduction, description of the different stages, and its life history, as far as known, the article concluding with a list of parasites and a consideration of remedies.

LIST OF FOOD PLANTS.

The list of plants on which this insect is known to feed can be inferred from the preceding to be a very long one, including as it does plants differing widely botanically as well as in flavor and texture.

In Europe it is comparatively innoxious, confining itself chiefly to weeds, such as chickweed (Stellaria), Litorella, plantain (Plantago), dock and sorrel (Rumex), Carduus and Centranthus, food plants reported by Kaltenbach, and others. When the species becomes unusually abundant in this country, injury appears to be about equally divided between garden and field crops and orchards, although garden vegetables are evidently the first crop to be attacked. In greenhouses it also does much injury, being one of the most annoying of the cutworms which attack plants grown under glass. The list of greenhouse and other ornamental plants affected includes violets, pansies, carnations, smilax, roses, sweet pea, hollyhock, sunflower, nasturtiums, and chrysanthemums. Grapes and lettuce are also much subject to injury when grown in cold frames. Of garden vegetables attacked are cabbage, turnips of different kinds, celery, lettuce, carrot, radish, beets, rhubarb, asparagus, onions, squash, potato, tomato, beans, peas, and bush fruits, including currant, gooseberry, raspberry, blackberry, and strawberry. Fruit trees of various sorts are sometimes divested of their foliage, as are also deciduous shade and forest trees. The list includes cherry, apple, pear, peach, prune, plum, cedar, mulberry, and box-elder. Of field crops it injures corn, wheat, timothy, and other grasses, alfalfa, clover, hops, and tobacco. Although not at all partial to weeds, it at times attacks nettle, thistle, dog fennel, fireweed, and several other kinds of weeds.

In its attack on cabbage it works in the same manner as the imported cabbage worm (*Pieris rapæ*), boring into the head and thus doing great damage. It cuts off the tender portions of almost all kinds of plants, including the heads of timothy. When it does not work in this manner it strips the leaves off its food plants. Mr. Slingerland, in writing of the injury by this species to chrysanthemums, states that a cutworm would climb a flower stalk and, upon reaching a blossom, firmly grasp the stalk just below with its prolegs, and then reach out as far as possible to the petals and eat them down to the base. The outer portion of the petals, which it could not reach, usually dropped to the ground.

While it is not probable that many succulent plants are exempt from attack, squash and other cucurbits, and the poppy, according to the testimony of our correspondents, are evidently distasteful, and would not be eaten provided more appropriate food was available. It is quite evident that this cutworm is capable of attacking any portion of a plant, as was witnessed during the year—flowers, buds, seeds, seed pods, leaves, tender stalks, tubers, roots, and even the bark of trees, particularly around grafts. It appears to prefer, as seems natural, flowers and tender leaves and seed-pods, and attacks other parts of a plant when the supply of the choice portions is exhausted. For example, after consuming the tops of such root crops as potato, turnip, onion, and carrot, all of which appear to be favorite food plants, this

cutworm attacks the tubers or bulbs; and, after devouring the foliage of fruit trees, it gnaws the bark.

LIFE HISTORY.

HIBERNATION AND ÆSTIVATION.

In regard to the manner of passing the winter, Mr. Slingerland (l. c., p. 104) sums up what has been published regarding the insect, which he believes indicates that it winters as a pupa or moth, the eggs being laid in the spring, notwithstanding the fact that, according to Dr. Forbes, hibernation sometimes takes place as larva.

To write with certitude in regard to a point in an insect's life history like hibernation, one must have the insect under observation in different seasons and in different localities. Recent observations by the writer in the neighborhood of the District of Columbia show that here at least this species passes the winter in the larval condition, although probably also as moth, and even as pupa. Messrs. Doane and Brodie "carried the insect through the winter in the pupal stage" at Pullman, Wash. This is probably seldom the case about the District of Columbia.

Early in October, 1899, the writer found an egg mass of this species on celery at Brookland, D. C. It was kept in a moderately cool room and by the close of the month larvæ hatching from these eggs and fed on celery leaves had attained nearly full growth, all of them disappearing into the earth by the 3d of November except one, which was diseased, and which will be mentioned later. December 20 moths began issuing in great numbers and deposited eggs in large masses in the rearing jar. The eggs hatched January 8 and 11, but we were unable to rear moths from this lot. Larvæ were found at intervals in warm spells during the winter, where they had come up under boards and in similar places for feeding. It seems probable that in the southern range of this insect breeding is almost continuous.

What has been related is sufficient to show extreme irregularity in development. The observations conducted by Dr. Fletcher in Canada show quite conclusively that the insect at least attempts to hibernate as pupa, although the fact that it does so appears to remain to be ascertained. November 9 two pupæ were dug up at Ottawa which produced the moth ten days afterwards indoors. The ground was covered with snow at the time and it seems probable that under such conditions hibernation would have been successful.

A larva of this species was obtained at Cabin John, Md., feeding on cabbage, January 15, 1900. It continued feeding a few days and then descended into the earth and was kept under continuous observation until August 20, when it transformed to pupa. During all this time, a period of seven months, this larva partook of no food and at times appeared nearly dead, as it scarcely moved when disturbed. The

imago issued September 10, the pupal stage having lasted twenty-one days.

This is a somewhat remarkable instance of prolonged æstivation, but not without parallel, a similar instance having already been recorded by the writer (Bul. 6, n. s., p. 88). In the instance cited protracted development occurred with the larva of *Ephestia kuehniella*, the Mediterranean flour moth. A similar irregular development has been noticed in *Cacœcia rosaceana*, the oblique-banded leaf roller.

While the larva above mentioned was under observation others were found and taken indoors for further study. One of these, taken March 23 under a board where it had fed on strawberry leaves, transformed to pupa April 20, the moth appearing about three weeks later, while other larvæ obtained a little later transformed to pupa May 11 and later, the first adult emerging May 31. The pupa stage in this case lasted ten days.

SUMMARY OF LIFE HISTORY.

From the summary of the life history of this species which has been made by Mr. Slingerland (l. c.), together with recent observations conducted by the writer, it is obvious that, although some data are missing, we have a fairly complete knowledge of the insect's life economy. Although it is very irregular in development, and is to be found practically in all stages throughout the year, at least in greenhouses and elsewhere indoors, it seems probable that as a rule this cutworm agrees with most others in passing the winter as larva, although hibernation takes place to a limited extent in the pupal and probably the adult conditions. In the State of Washington hibernation in the pupa state appears to be normal. From the fact that attack has been often noticed in May—for example, at St. Charles, Mo. (on the 23d, as previously recorded, and two days later at Washington, D. C.)—it is obvious that much injury may be done in spring by over-wintered larvæ. Dr. Riley was of the opinion that there were at least two and possibly three generations of this species produced in the latitude of St. Louis, and there is reason to believe that this will hold good for the District of Columbia and vicinity. Attack, then, of hibernated larvæ begins in a latitude like that of the District sometime in May. A second generation is produced which causes injury in July and August. The majority of these insects probably disappear toward the end of the month of August, but some of them transform to pupæ and afterwards to moths which lay eggs for an exceptional third generation. It seems probable that whatever is the life history it does not vary much throughout the region in which this species is injurious and we would expect to see the same or a very similar life history in Washington and Oregon, where this cutworm was so destructive during the past season. The last generation is produced so late in the season and is so small in extent that comparatively little injury is done. Of the cases

recorded in previous pages, it would seem that injury is about equally divided between the first and second generations. This, however, is a matter that it would be difficult to decide, as it is impossible to separate the two broods.

Reports of injury during 1900 were almost continuous and were accompanied by specimens, as a rule at or near maturity, from May 12 to the first week of September.

The duration of the egg stage was noted in a moderately cool room, average temperature of 60°–68°, and ascertained to be three weeks. In midsummer this stage is, of course, much shorter. The larval stage probably lasts between three and four weeks, according to temperature, and the period of æstivation, as previously stated, may extend over seven months. The pupal stage was observed to be between ten and twenty-one days, and may be much longer when winter is passed as pupa.

NATURAL ENEMIES.

As with the army worm, and to a lesser extent with the 1899 outbreak of the fall army worm, much was expected, by those who had the variegated cutworm under observation, from parasitic and other natural enemies which often attack and destroy insects having the habit of periodically traveling in armies. With the fall army worm it has been shown that the natural enemies were somewhat of a disappointment, and the same was to a certain extent true in the case of the variegated cutworm in its occurrence in British Columbia, as elsewhere. Locally, however, natural enemies were of some service, and possibly more beneficial than observations go to show. It seems probable that in many cases destructive elements were at work that escaped notice.

Two of our correspondents previously mentioned, Messrs. Willis and Mayse, of Oregon, have written of the efficacy of chickens as destroyers of this cutworm. In one case chickens were turned into a garden, and they partly cleared the plants of the worms. Mr. Mayse stated that hogs and some birds were very fond of this cutworm, and were quite destructive to it.

From the latter correspondent also we received from Dora, Oreg., parasitized specimens, the parasites from which issued late in August, and proved to be, according to Mr. Coquillett's determination, the Tachina fly (*Phorocera saundersii* Will.).

From the same correspondent we received July 21 a *Peridroma saucia* larva upon which a larva of a Therevid was preying.

The Tachina fly (*Archytas analis* Fab.) issued June 25 from a pupa of this cutworm obtained from Eureka, Ill. The following day it was reared from *Leucania unipuncta* received from McPherson, Kans., where the variegated cutworm was also present during the year.[1]

[1] This species is also parasitic on *Clisiocampa californica* Stretch.

From material received from Mr. Willis, Olga, Wash., a number of parasites of *Ichneumon capitus* Cr. issued during the last days of August and first of September. As near as could be estimated, fully 50 per cent of the pupæ received from our correspondent in one lot were parasitized by this Ichneumon fly.

Evidence was afforded March 2 that a common ground beetle, *Scarites subterraneous* Fab., preys upon the variegated cutworm. On that date a larva was found, under a board, that had evidently been killed by this insect, which was feeding upon it at the time of capture. All of the natural enemies of this cutworm which have been mentioned have come under observation during the season of 1900.

In Dr. Fletcher's article (loc. cit., pp. 225–227) two pages are devoted to the subject of parasites and predaceous enemies. At Victoria, British Columbia, three lots of larvæ were almost all destroyed by the maggots of a parasitic fly, Tachinid judging by the description. The presence of Tachina eggs on the heads of cutworms was reported at Salt Spring Island. A large black fly, presumably an Ichneumonid, was observed at Vancouver. One parasite was identified (*Meteorus vulgaris* Cres.) from British Columbia.

Two parasites identified as destroying this cutworm are placed on record by Messrs. Doane and Brodie (Bul. 47, Wash. Agl. Expt. Sta., 1901, p. 10). They are *Ichneumon maurus* Cr. and *Meteorus indagator* Riley. Three other species of Tachina flies are parasitic on the variegated cutworm. These are: *Chætogædia monticola* Bigot, *Gonia capitata* DeG., and *Winthemia 4-pustulata* Fab. The last mentioned has been figured in the paragraph on the natural enemies of the fall army worm.

A very large proportion of the larvæ received late in the season from the Pacific States died under conditions which would have been favorable to most caterpillars. It is not improbable that disease was present when the material was gathered, but of this we can not be certain, since it is a matter that would have to be decided by residents or at least persons temporarily resident in the infested sections, as larvæ confined in unnatural conditions for some time are apt to develop diseases which might not have affected them in the field. Their decease was probably due to the same cause as that noticed by Doane and Brodie, and by Fletcher in British Columbia—i. e., to bacteriosis. According to Dr. Roland Thaxter, who examined material from the latter source, cutworms are subject to *Empusa aulicæ*, and that authority on fungous diseases expressed the opinion that, if careful investigation had been made during the invasion, this or some other species of Empusa would have been found destroying them.

In British Columbia robins, crows, the blue jay, chickens, ducks, and pigs were reported to have been observed destroying this cutworm.

In the State of Washington chickens, turkeys, guinea hens, and other poultry, as well as crows, did good work in repressing this species.

From what has been said in previous paragraphs the utility of domestic fowls and other animals is obvious. With proper judgment their services would save great losses that it might otherwise be difficult to avert.

Poisoned bait, a standard remedy against cutworms, is of value against this species under ordinary circumstances. To be effective it should be applied as soon as attack is noticed. It can be prepared in the ordinary manner by mixing. It is particularly valuable in cases where the direct application of poisons to a plant is impossible owing to the danger of poisoning persons or stock when it is used for food. There are two kinds of bait—fresh vegetable and bran mash.

Vegetable bait.—A good way of preparing a vegetable bait is to spray a patch of clover, pigweed, or some useless succulent plant that grows by the roadside or in fence corners, with Paris green, 1 pound to 150 gallons of water; mow it close to the ground, and place it while fresh in small heaps about the infested plants at intervals of a few feet. The later in the day that this can be done the better, as the material keeps fresh longer and the cutworms feed almost exclusively at night. Owing to the wilting of this bait, particularly in dry, sunny weather, it is advisable to cover each heap with a chip, shingle, or bit of bark for its protection against the sun's rays.

Bran mash.—What is known as bran mash or bran-arsenic mash is of equal value to a fresh vegetable bait, and, according to some, still more efficacious. Paris green, arsenoid, white arsenic, or in fact any arsenical can be used for poisoning this bait, and in its preparation, on account of the weight of the poison and the fact that it soon sinks to the bottom of the water when stirred, it is best first to mix the bran with water and sugar and then add the poison. The proportions are 2 or 3 ounces of sugar or a similar quantity of glucose or molasses to a gallon of water and a sufficient amount of bran (about a pound per gallon) to make, when stirred, a mixture that will readily run through the fingers.

Before planting a crop it is advisable to employ such bait, and for its perfect success the ground should be bare, which will have the effect of practically compelling the cutworms to feed upon it.

Protection of plants that are set out, such as tomato, cabbage, and others, started under glass, may be secured by placing about the base of each a tablespoonful of the poisoned bran or a small bunch of the poisoned vegetable. Sometimes it is feasible also to dip the plants in poison before setting out. Where it is possible, however, to spray grass or weeds which have grown up in fields about to be cultivated, this should be done, as it is an easy means for riddance of the cutworms and is less troublesome than the preparation and distribution of baits.

Protection of trees.—Numerous preventives of injury to fruit and other trees by climbing cutworms and other caterpillars with habits like the present species have been devised, and some have been found quite satisfactory. The method of protection in question consists, in brief, in placing about the trunk of each tree a band or ring of smooth or tarred paper, cotton batting, or adhesive substances, over which the "worms" can not crawl. The best of these is cotton batting, and in its application a good way is to cut thin sheets into strips 4 or 5 inches wide, long enough to reach around the tree and to be wrapped tightly to the tree at the bottom, so that the band rolls over the lower edge, standing out somewhat from the tree and forming a sort of funnel or cone-shaped mass of batting. These bands or collars, it is claimed, are effective for a whole season, as they become dry after being wet by rain. Adhesives are sometimes dangerous, particularly if applied to young trees.

Bordeaux mixture.—This fungicide, according to Messrs. Doane and Brodie, was tested recently against the variegated cutworm upon potato vines and asparagus. It was sprayed on as a remedy for blight, and it was discovered that the plants thus treated were free from attack by this cutworm. The use of this fungicide as a cutworm deterrent is certainly advisable. In any case, it should be used as a diluent for whatever arsenical is used.

Hand methods.—On some plants it is next to impossible to apply any but hand methods with good results. Experiments in Washington State during the season of 1900 demonstrated conclusively that in some cases it required less time to shake or brush the variegated cutworm off from affected plants than to destroy them by means of spraying or otherwise.

Greenhouse methods.—A few words should be said in regard to remedies to be employed in cases of greenhouse infestation by this cutworm. The poisoned baits are, of course, applicable here, and the hydrocyanic acid gas treatment of a greenhouse when employed for aphides and other insects will help to destroy these worms, especially when they are young. Its use can not be advised, however, for cutworms alone. In ordinary cases they can be held in check by hand-picking. It is the custom of some florists to hunt for them at night with a lantern, when they are feeding and can readily be discovered and destroyed.

Treatment as an army worm.—When the variegated cutworm assumes the habit of traveling in armies it should be treated in the same manner as advised against the fall army worm in preceding pages.

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PREPARED UNDER THE DIRECTION OF THE ENTOMOLOGIST

BY

F. H. CHITTENDEN,
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